The effects of a combined intervention targeting executive function and theory of mind on social interference in people with acquired brain injury

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Empirical Research Project and Systematic Literature Review

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“*Does anyone ever get this right?*
I feel no love.”
Queens of the Stone Age (2013)

Empirical Research Project

The Effects of a Combined Intervention Targeting Executive Function and Theory of Mind on Social Inference in People with Acquired Brain Injury

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Abstract

Many people with acquired brain injury are affected by social cognition and executive function difficulties, including the perception, processing, and decision-making based on interpersonal information. This study sought to examine the effectiveness of an external prompt, content-free cueing, to support participants in their performance on a measure of social cognition, the Strange Stories Task, in a within-subjects design. Twenty-five participants had known social cognition difficulties and were recruited from a communal neurorehabilitation centre. In the experimental 'strategy cue' condition, participants were instructed to invoke an earlier brief training on perspective-taking. In the control 'tally cue' condition, participants were required to count the number of content-free cues on a piece of paper. Participants' responses on the Strange Stories Task were not significantly more accurate, but they responded roughly 0.75 s more quickly in the 'strategy cue' condition compared to the 'tally cue' condition. However, this was only the case when participants completed the 'strategy cue' condition after the 'tally cue' condition. Findings and clinical implications are discussed in the context of supporting people's social cognition alongside executive function difficulties after acquired brain injury.

Acquired brain injury (ABI) is defined as damage to the brain which occurs after birth, the cause of which is unconnected to congenital or degenerative diseases (World Health Organization, 1992). ABI has a variety of causes, including traumatic accidents (e.g. road accidents, falls or assaults), cerebrovascular incidents (e.g. haemorrhage, ischemia), brain tumours, exposure to toxins, oxygen deprivation (i.e. hypoxia/anoxia) and infection or inflammation (i.e. encephalitis; Turner-Stokes, Pick, Nair, Disler, & Wade, 2015). According to Headway, a national brain injury charity, 348,453 people were admitted to hospital across the UK for ABI in 2016-17; this equates to a rate of 531 per 100,000 citizens (Headway, 2019). The effects of ABI are often wide-ranging and encompass physical, sensory, cognitive, and emotional changes. These can in turn reduce functional independence, impact negatively on interpersonal relationships, and limit quality of life (De Luca et al., 2018). As a result, the rehabilitation of people with ABI may require significant public health expenditure, depending on the individual's care needs (Adamson et al., 2004).

Any domain of cognitive function may be affected by ABI, from perception and attention to memory, language, and manipulating information in one's mind (Storey & Kinsella, 2007). A person's cognitive deficits and their severity are typically associated with the type, size, and location of the respective brain damage (Burgess & Wood, 1990; Wilson, 2002). In addition, profiles of cognitive performance following ABI may reveal specific, interlinked or diffuse impairments and can vary greatly between individuals (Gennarelli et al., 1998). This presents a challenge for the planning and targeting of neuropsychological rehabilitation (Mollayeva et al., 2019; Tornås et al., 2019). It has been hypothesized that milder injuries tend to produce temporary and more constrained cognitive impairments (Azouvi et al., 2017), though some research has challenged this assumption (Nelson et al., 2019). One clear exception is the post-concussive syndrome, as certain non-specific symptoms (e.g. anxiety, depression, sleep disturbance, cognitive impairment such as difficulty concentrating, emotional lability, irritability, dizziness, fatigue and/or headaches) may remain beyond the typically prognosticated recovery period in 10-20% of those with traumatic brain injury (Broshek et al., 2015). Moderate to severe injuries tend to be linked to long-lasting cognitive deficits and require multi-disciplinary rehabilitation input (Cicerone et al., 2000, 2005; Langhorne et al., 2017).

Executive Functions in Acquired Brain Injury

ABI is often linked to deficits in executive function (EF) abilities. EF is a summary term whose precise definition and substituent components are points of some contention (Burgess, 2004; Miyake et al., 2000). There is relative agreement, however, that EFs

represent some of the most advanced cognitive functions and deficits in this area are usually associated with frontal lobe damage (Hunt et al., 2013). It has also been acknowledged that other brain regions outside the frontal lobes also support EFs (Alvarez & Emory, 2006; Masterman & Cummings, 1997; Stuss, 2011a) and that these may be affected by ABI. Examples of EFs include cognitive flexibility, self-monitoring, initiation and inhibition, decision-making, problem-solving, task-shifting as well as sequencing, organising, and planning (Mueller & Dollaghan, 2013). People affected by EF difficulties may demonstrate deficits in their daily lives with planning and carrying out activities (particularly if these include multiple components) as well as with sequencing tasks, maintaining attention on relevant goals, and inhibiting inappropriate behaviour (Manly et al., 2002; Manly & Murphy, 2012).

Social cognition in Acquired Brain Injury (ABI)

Many people with ABI are also affected by social cognition (SC) difficulties. SC involves how people think, act, and feel about themselves and others in interpersonal situations; it relies on cognitive abilities which include social perception, evaluation, and self-regulation (Cassel et al., 2019; S. McDonald, 2013). Common difficulties people with ABI experience in this area are ineffective communication as well as finding it harder to share experiences and predict the experiences of others (S. McDonald, 2013). Consequently, they may face reduced social interaction (Driscoll et al., 2010), poorer social support (Yates, 2003) or mental health difficulties (Henry et al., 2016). Henry and colleagues (2016) state that concerns about potential SC difficulties typically come to the attention of professionals through a person's presenting history, through a diagnosis associated with SC impairment, an informant raising concerns or unusual behaviour being observed in clinic. The authors go on to describe a five-step algorithm for the evaluation and treatment of SC impairments, encompassing clinical case identification, SC assessment, differential diagnosis, treatment, and follow-up.

Four primary areas that might be assessed by neuropsychologists in this context are social perception, affective empathy, social behaviour, and theory of mind (ToM) – ideally using a combination of clinical observation and standardised self-report, informant-rating, and ability-based assessments (Henry et al., 2016). Social perception tasks often require participants to identify or match emotional labels to pictures of faces, such as labelling and discrimination tasks using Ekman Faces (Ekman & Friesen, 1976) or the Florida Affect Battery (Bowers et al., 1999). Affective empathy is typically assessed using self- or other-report questionnaires, such as the Empathic Concern (Davis, 1983) and Empathy Quotient (Baron-Cohen & Wheelwright, 2004) scales. The Multifaceted Empathy Test (Dziobek et al.,

2008), in turn, elicits participants' responses to photographic images with strong emotional content. The assessment of social behaviour also commonly relies on questionnaires, like the self-rated Frontal Behavioural Inventory (Kertesz et al., 2000) or the clinician-rated Social Impairment Rating scale (Bickart et al., 2014). Under the heading of ToM, a variety of tasks are available, such as The Awareness of Social Inference Test (S. McDonald et al., 2003), False Belief tasks (Wimmer & Perner, 1983), the Faux-Pas Test (Stone et al., 1998), and the Strange Stories Task (SST; Happé, 1994). The ToM tasks have in common that they require participants to answer questions about a brief social story by making inferences about the characters contained within them. Similar tasks involving visual or video representations exist as well, such as the Reading the Mind in the Eyes Test (Baron-Cohen et al., 2001) or Strange Stories Film Task (Murray et al., 2017), respectively.

The focus of the present research is on ToM for three primary reasons. First, ToM deficits have been hypothesised as one of the core impairments in SC following ABI (Martín-Rodríguez & León-Carrión, 2010). Second, Vallat-Azouvi, Azouvi, Le-Bornec, and Brunet-Gouet (2019) have argued that SC interventions should be "contextualized, collaborative, and experiential" (p. 87). This appeared most likely achievable using ToM tasks, given that they regularly employ rich examples from everyday experiences. They also draw on participants' detailed interpretations, rather than eliciting one-word answers or numerical ratings for stimuli that are potentially isolated from their context, as with some of the measures outlined above. Third, a number of studies have previously demonstrated the efficacy and value of ToM interventions in conditions such as schizophrenia (Biedermann et al., 2012; Vass et al., 2018) and autism (Begeer et al., 2011; Gillberg, 2013; Pelphrey et al., 2011).

ToM is commonly defined as the capacity to consider one's own and others' mental states as well as ability to infer mental states (Baron-Cohen, 2000). ToM tasks, specifically, often focus on participants' skill in reasoning about others' beliefs and can be classed into first- and second-order subtypes (Stone, 2006). First-order ToM tasks require the ability to make inferences about someone else's state of mind (e.g. 'Paul thinks that the object is in location A'). Second-order ToM tasks rely on the ability to postulate that one individual has beliefs about another individual's mental state (e.g. 'Mary thinks that Paul thinks that the object is in location A'). Thus, second-order ToM tasks add another layer of complexity (Martín-Rodríguez & León-Carrión, 2010). First-order ToM tasks are usually passed by typically developing children around the age of 4 years, while second-order ToM tasks are not passed until the age of 6 or 7 years (Fazaeli et al., 2018). The primary task used in the present study, the Social Stories Task, is a sensitive assessment tool that measures ToM, having been found to elicit deficits in young people with autism spectrum disorder who had previously passed second-order ToM tasks (Happé, 1994).

The two main models which have been put forward to explain ToM in psychological terms are Theory Theory and Simulation Theory (Bivona et al., 2018). The former posits that people use knowledge about interpersonal relationships acquired from their respective culture and unwritten social laws to form ToM hypotheses, similar to a scientific theory (Carruthers & Smith, 1996; Davies & Stone, 1998). Simulation Theory proposes that people model their own internal states, based on autobiographical experience and internal affective simulation, to make deductions about others' mental reasoning (Decety & Grèzes, 2006; Gallese et al., 2004). Prior research has shown that some individuals after ABI demonstrate a bias towards interpreting others' behaviour or utterances as negative, intentionally hurtful or potentially threatening (Callahan et al., 2011; Dresang & Turkstra, 2018; Neumann et al., 2017). It is possible that excessive reliance on Simulation Theory over Theory Theory could contribute to this particular difficulty, though an experimental investigation remains pending.

Aboulafia-Brakha, Christe, Martory, and Annoni (2011) found 64% congruence between impairments in EF and ToM across 24 studies involving people with ABI, suggesting close links between the two areas of cognitive function. However, this study did not resolve whether this was due to related cognitive mechanisms, brain circuitry or both. Anatomically, ToM is hypothesised to be supported by the dorsomedial prefrontal cortex and the temporoparietal junction (Henry et al., 2016; Schurz et al., 2014). Moreover, of the ToM tasks that formed the focus of the systematic review, the SST yielded the lowest congruency between ToM and EF. Specifically, if people after ABI were impaired on EF, they presented with deficits in ToM in only 36% of the studies reviewed (Aboulafia-Brakha et al., 2011; Happé, 1994). The authors argue that this suggests the SST is less associated with EF, indicating that it offers a more specific test of ToM, or that a significant EF impairment would need to be present in order to effect performance on the SST.

Neuroanatomy of Social Cognition and Executive Function

A variety of areas have been implicated in the cerebral processing of social cognition, particularly in the pre-frontal, temporal, parietal, and subcortical areas (Adolphs, 2001; Lieberman, 2007; Mccall & Singer, 2012; Van Overwalle, 2009; Walter, 2012). For the purposes of this study, neural correlates for ToM processing will be examined in more detail. Adolphs (2001) comments that ToM is dependent on elements of social perception, cognition, and behaviour, which are involved in mutual feedback loops. He reports that verbal and non-verbal ToM tasks are processed in the medial prefrontal (mPFC) and cingulate areas while visual motion of simple shapes may activate the left medial prefrontal cortex (L mPFC), superior temporal sulcus (STS) and amygdala. Lieberman (2007) states that neuroimaging studies have identified a network consisting of the dorsomedial prefrontal

cortex (dmPFC / BA 8, 9), posterior superior temporal sulcus (pSTS), and temporal poles. A meta-analysis by Van Overwalle (2009) highlighted the inferior, or ventral, and right temporo-parietal junction (iTPJ / R TPJ), dorsomedial prefrontal cortex (dmPFC), ventromedial prefrontal cortex (vmPFC), as well as inferior and right prefrontal cortices (iPFC / R PFC) as important in the processing of ToM. The review by McCall and Singer (2012) focussed mostly on the neuroendocrinology of social cognition (e.g. involving neurotransmitters such as oxytocin), but lists the medial prefrontal cortex (mPFC), precuneus, superior temporal sulcus (STS), and right temporo-parietal junction (R TPJ) as crucial to ToM. Walter (2012) reports that the temporo-parietal junction (TPJ), superior temporal sulcus (STS), dorsomedial prefrontal cortex (dmPFC), precuneus, posterior cingulate cortex (PCC), and medial superior parietal cortex (mSPC) as unique to cognitive ToM as opposed to cognitive empathy/affective ToM and affective empathy. Taken together, findings from the above reviews suggest that there is some consensus around the involvement of the dorsal and/or ventral medial prefrontal cortex (dmPFC / vmPFC), susperior temporal sulcus (STS), and temporo-parietal junction (TPJ) during ToM tasks. The recruitment of the amygdala, temporal poles, precuneus, and anterior/posterior cingulate (ACC / PCC) is, however, not shared between reviews.

It is also worth drawing attention to the concept of 'mirror neurons' while discussing ToM (di Pellegrino et al., 1992; Iacoboni et al., 1999; Rizzolatti et al., 1996). They have been found to activate in the prefrontal cortex of primates "both when the monkey executes an action and when it views another individual performing the same action" (Adolphs, 2001), suggesting a cortical mechanism for the action simulation of goal-directed behaviour. Findings particularly from fMRI research suggests the presence of a mirror neuron *system* (MNS) in humans (e.g. inferior frontal gyrus [IFG], ventral premotor cortex [vPMC], and posterior intraparietal sulcus [pIPS]), as single-cell recording is typically not possible in healthy persons (Walter, 2012). It has been suggested that the human MNS may serve to recognise and learn from others' behaviours, experience, and intentions. Evidence for this is still lacking and mirror-neuron related tasks appear to activate lateral, rather than medial, prefrontal areas; yet the possibility remains that the MNS is recruited during the perception of facial emotions (Lieberman, 2007). As the present research was concerned with participants' ability to simulate others' minds, as opposed to action observation and emulation, the role of mirror neurons did not receive further emphasis in the experiment.

A number of reviewers have proposed working definitions for executive function as well as underlying networks (Collette & Van Der Linden, 2002; B. C. McDonald et al., 2002; Stuss, 2011a; Suchy, 2009; Yuan & Raz, 2014). McDonald and colleagues (2002) include in their classification of EF areas encompassing the dorsolateral (dlPFC), orbital (oPFC), and medial (mPFC) prefrontal cortices and subcortical structures, like the thalamic nucleu, basal

ganglia, and parts of the cerebellum, as well as projections between them. Suchy (2009) argues that all parts of the prefrontal cortex anterior to the motor/pre-motor cortices support executive function, including dorsolateral (dlPFC), superomedial (smPFC), ventral/inferior (iPFC), and frontal pole. He points out that, depending on the type, EF processes are supported by networks within the prefrontal cortices which have connections to cortical and subcortical structures, such as the parietal lobes, basal ganglia, thalamus, and cerebellum. Stuss (2011a) counts under regions required to sustain EF dorsomedial (dmPFC), ventro-medial (vmPFC), and orbital (oPFC) prefrontal cortices as well as the frontal poles. He refers to "frontal/subcortical anatomical circuitry," though these are not specified. Yuan and Raz (2014) equally noted that different areas are recruited for EF, depending on the task, such as the inferior parietal lobule (IPL), anterior cingulate cortex (ACC), and lateral prefrontal cortices (lPFC) during the Wisconsin Card Sorting Test, the anterior cingulate gyrus (ACG) and inferior frontal gyrus (IFG) during the Stroop Task, and a fronto-parietal network during working memory tasks. Evidence is therefore converging that large sections of the prefrontal lobes appear dedicated to EF, to the extent that the terms 'executive' and 'frontal' are at times used interchangeably in the literature (Yuan & Raz, 2014). Smaller, distinct networks may become activated depending on the type of EF and interact with other cortical and subcortical structures (e.g. parietal lobes, thalamus, and basal ganglia) in feedback loops.

In sum, there appears to be overlap in the cerebral areas which are activated by SC and EF tasks, specifically in the prefrontal cortex. Overall, EF recruits more lateral and SC more medial prefrontal cortices. This lends evidence that deficits in EF and SC may often be linked due to nearby or overlapping cortical-subcortical networks and supports the notion that considering them jointly in rehabilitation is worthwhile (Manly & Murphy, 2012; Westerhof- Evers et al., 2019; Yeates et al., 2016).

Rehabilitation for Social Cognition Difficulties

The treatment of SC and ToM difficulties after ABI is a somewhat new and developing area. Vallat-Azouvi and colleagues (2019) have reviewed the current literature using a narrative approach and found multi-dimensional interventions as well as interventions focussed on social-cognition subcomponents. The authors identified five studies relating specifically to ToM, two of which were randomised controlled trials. The review highlighted the first randomised control trial (RCT) which encompassed twenty one-hour sessions of training in which earlier exchanges of 16 participants with a conversation partner were analysed based on audio recordings (a procedure called Interpersonal Process Recall; Helffenstein & Wechsler, 1982). The study found significant improvements in self-reported interpersonal communication (Cohen's $d = 1.09$; calculated based on reported *F*-

score and sample sizes), interpersonal skills as reported by staff members blinded to condition (Cohen's $d = 1.27$), and relationship skills (Cohen's $d = 1.52$). However, improvements in self-reported anxiety, self-reported self-concept or structured video analyses of their interactions were not detected. Outcomes were maintained over a one-month period, though this has to be treated with caution due to the reduced sample size on follow-up ($n = 6$; Helffenstein & Wechsler, 1982). Dahlberg and colleagues (2007) offered 12 one-and-a-half hour group treatment sessions for social communication skills to 52 adult participants whose injury had occurred at least one year prior. The treatment incorporated a variety of SC elements, e.g. developing conversation strategies and social problem-solving. Significant improvements, compared to a non-treatment control group, were found on two questionnaire measures assessing communication skills, one blind-rated by the experimenter, the other as both self- and informant-report. Finch, Cornwell, Copley, Doig, and Fleming (2017) targeted social communication deficits in pre-post design study using a 16-hour individual and group-based training based on meta-cognitive principles, such as breaking complex tasks into smaller components and task-concurrent self-reflection. Six of eight participants achieved their communication goals but there were no significant improvements on the standardised measures, namely the Profile of Pragmatic Impairment in Communication (PPIC; Linscott, Knight, & Godfrey, 2003) or on the LaTrobe Communication Questionnaire (LCQ; Douglas, O'Flaherty, & Snow, 2000). In a case study of two participants, Winegardner, Keohane, Prince, & Neumann (2016) delivered perspective-taking training over six weeks with an emphasis on reducing the hostile attribution bias. Relatives reported better perspective-taking and reduced aggression on interview, though scores on measures of aggression and empathy did not differ significantly. Lastly, Gabbatore, Sacco, Angeleri, Zettin, Bara, and Bosco (2015) offered 15 participants a 24-session, pragmatic communication training which included sessions on verbal, non-verbal, and socially appropriate communication. Significant improvement was demonstrated on all scales of the Assessment Battery for Communication (ABaCo; Angeleri, Bosco, Gabbatore, Bara, & Sacco, 2012; Sacco et al., 2008), though not on two measures of ToM, the Sally-Anne Task (Wimmer & Perner, 1983) or the SST (Happé, 1994).

In summary, several studies have investigated the rehabilitation of SC problems in people with ABI. With the exception of Gabbatore and colleagues (2015), improvements were found on self- and other-report measures, though rarely on standardised tasks, including those assessing ToM. Effects were sometimes short-lasting. The review concluded that effective treatments for SC and ToM impairments following ABI are scarce compared to those available in psychosis and autism spectrum disorders (Vallat-Azouvi et al., 2019). In addition, previous international clinician surveys have identified gaps in clinical practice regarding the use of standardised tools for SC assessment (Kelly et al., 2017b) and

treatment (Kelly et al., 2017a). The issue is particularly pressing as ToM impairments after ABI may significantly hinder people's independent living, social activities, and quality of life (Bivona et al., 2015; Rilling et al., 2004; Wood & Worthington, 2017).

Cognitive Rehabilitation and Content-Free Cueing

Current brain injury rehabilitation in the UK draws on a holistic model incorporating cognitive, emotional, social, and behavioural theories to understand a person's deficits and develop collaborative goals for intervention (Wilson, 1997, 2008). Psychologists working in such settings have a variety of tools at their disposal, including restorative and compensatory methods (Mahan et al., 2017; Wilson, 2002; Zangwill, 1947). Restorative techniques aim to attempt to restore lost or damaged functions, though not necessarily to the premorbid level, generally by using specialised cognitive exercises (De Luca et al., 2018). Compensatory strategies involve adjustments to a person's behaviour and/or environment (e.g. using a digital diary with reminders to aid memory for future events) to adjust for their cognitive limitations, potentially drawing on other faculties which have been preserved (Wilson, 1997).

One such compensatory technique is content-free cueing (Fish et al., 2007; Manly et al., 2002, 2004). A content-free cue is an external prompt which carries no inherent message – other than that imparted in the initial instructions – and occurs at periodic intervals not directly related to the task being performed. The content-free cueing paradigm assumes participants have understood and internalised goals or task instructions, but may fail to implement these when required or use them inconsistently, due to difficulties e.g. with retrieval, working memory or executive control (Manly et al., 2002). The content-free cue is intended to serve as an alerting and attention-grabbing environmental stimulus to encourage participants to evaluate their current goal state (Fish et al., 2010; Manly et al., 2004).

There are some precedents for content-free cueing being used effectively in rehabilitation research. In a study by Manly et al. (2002), the authors found improved multi-tasking performance in patients when using content-free cueing compared with an inexpressive sound. Furthermore, in the cueing condition patient performance was indistinguishable from that of control participants. Of note in this study, the client group was matched for current IQ to the control group, adding additional evidence that the core challenge being addressed was EF as opposed to a disparity in general intellectual ability. Since then, further work has applied content-free cueing to prospective memory for patients to achieve daily goals and intentions in the community (Fish et al., 2007; Gracey et al., 2017). Taken together, the rationale for using content-free cueing in the present research is

that it may support people with ABI to increase the likelihood of achieving goals which they have formed and retained, but which they may struggle to monitor sufficiently in situ.

Study Aims and Overview

The current study is a proof-of-concept experiment which aimed to investigate if content-free cueing could enable people with SC problems after ABI to make more accurate social inferences on a ToM task.

1. All participants with acquired brain injuries were first trained in perspective-taking, specifically using an adapted version of the Theory of Mind module from the Meta-Cognitive Training for Psychosis (Moritz, Veckenstedt, et al., 2013; Moritz, Woodward, et al., 2013).

2. The participants then completed the SST (SST; Happé, 1994). The SST was split into two halves. In one half, participants underwent the experimental procedure, termed the 'strategy cue' condition. In the other half, they underwent a control condition, terms the 'tally cue' condition. For both halves a sporadic 'bleep' sound was played in the background, the content-free cue. In the 'strategy cue' condition, participants were instructed to use their ToM training to aid performance on the task (see below for precise instructions). In the 'tally cue' condition, they had to make a record of how many tones there had been. There was counterbalancing of orders as indicated in the Design section below.

3. SST performance was used as the outcome measure for each condition. Comparisons were made between the 'strategy cue' and 'tally cue' conditions for the participant group combined (within-subject comparison), as well as for the order of SST halves across participant groups (between-subject comparison).

Participants were administered several background measures to characterise the cognitive profile of the sample. The selected tasks aimed to assess participants' estimated pre-morbid IQ, current IQ, attention, memory, language, and EF. As a secondary benefit, the tasks allow the exploration of the relationship between task performance and the above-mentioned aspects of cognitive ability as well as between any cueing effect and cognitive ability.

Participants and their significant others completed a SC and an EF questionnaire each to further describe the sample. As an ancillary goal, the questionnaires permit the

supplementary analyses of relationships between task performance and SC. Lastly, informal feedback was collected from participants to gain initial insight whether they considered taking part in the research feasible and acceptable.

Method

Design

The study used a within-subjects design. It contained two conditions, 'strategy cue' and 'tally cue,' outlined below. All 24 participants completed both conditions. Participants were allocated to one of two orders: 'strategy cue' condition first or 'tally cue' condition first, the sequence of which was counter-balanced across groups using the allocation procedure detailed in table 1.

Table 1. Administration order.

Table 1

Administration Order

Group	Participant Number	Part 1 of Session 1	Part 2 of Session 1
1	1, 8, 9, 16, 17, 24;	Tally condition, SST half 1	Strategy condition, SST half 2
2	2, 7, 10, 15, 18, 23;	Tally condition, SST half 2	Strategy condition, SST half 1
3	3, 6, 11, 14, 19, 22;	Strategy condition, SST half 1	Tally condition, SST half 2
4	4, 5, 12, 13, 20, 21.	Strategy condition, SST half 2	Tally condition, SST half 1

This research was reviewed and given a favourable opinion by London Riverside REC (IRAS #248547; see Appendix 1).

Measures

The measures encompassed the SST, a neuropsychological battery, and two questionnaires, as detailed below.

Strange Stories Task (Happé, 1994). The SST is a test of social cognition, specifically measuring theory of mind. The original aim of the SST was to distinguish participants with and without a diagnosis of an autism spectrum disorder using naturalistic and complex stories. Research has demonstrated the SST's adequate validity and reliability (Devine & Hughes, 2016; Shahrivar et al., 2017). The SST has previously been used in children and adults with autism spectrum disorders, including under Asperger's syndrome (Kaland et al., 2005; Murray et al., 2017), specific language impairment (Gillott et al., 2004), ABI (Umeda et al., 2010), frontotemporal dementia (Serrani, 2011), psychosis (Hur et al.,

2013; Stanford et al., 2011), alcohol abuse (Bosco et al., 2014), personality disorders (Duijkers et al., 2014), epilepsy (Giorgi et al., 2016; Lew et al., 2015), and attention-deficit hyperactivity disorder (Bigorra et al., 2016). It has also been applied in people ranging in age from 10 months (Kirk et al., 2015) to 82 years (Cavallini et al., 2013), as well as in various adolescent samples (e.g. Henderson et al., 2009). To the author's knowledge, the SST has previously been involved in a variety of studies with participants with ABI for assessment purposes, but not as an outcome measure in a study using experimental manipulation. The SST consists of 12 types of vignettes, two of each of the following kind: lie, white lie, joke, pretend, misunderstanding, persuade, appearance/reality, figure of speech, sarcasm, forget, double bluff, and contrary emotions. The SST's 24 vignettes were split to create two half-forms each with twelve items, one from each of the twelve categories. After reading each vignette, participants were asked to respond to a comprehension question ("Was it true, what [the character] said?") and a justification question ("Why did [the character] say that?"). We considered matching stories by difficulty between the two halves. However, the extant literature only reports performance outcomes on the category level (e.g. lie, white lie), but not on the item level (Jolliffe & Baron-Cohen, 1999; Kaland et al., 2005; White et al., 2009), so this was not possible. The SST halves, with relevant questions, are found in Appendix 2.

The SST was presented as a printed booklet with one story and its related questions per page. Participants listened to the stories through laptop speakers using recordings prepared by the examiner. This was done for uniformity and with the aim of assessing SC skills over other cognitive skills, such as basic reading ability. In addition, unlimited repetitions of the story and questions were permitted to reduce demands on cognitive processes, such as memory. However, at most, participants asked for one repetition of the instructions. In addition, participants were prompted to answer the questions if they had not replied within 60 s of hearing or reading the story question at hand or if it became apparent that they had become distracted. Participants' verbal responses were recorded verbatim on paper by the examiner as well as audio-recorded for accuracy and subsequent timing purposes.

Scoring of the primary outcome variable. The main outcome variables for the SST were Accuracy and Response Time. In terms of Accuracy, the original items in the study contained a 'yes/no' as well as a justification question (e.g. "Why does she say that?"). However, in previous research by the developer of the measure, only the justification question was coded. In this study, both questions were coded and scored. The reasons for this were that responses to justification questions were considered integral to an appropriate scoring of participants' responses and to obtain detailed information about the thought processes underlying participants' binary responses. Self-corrections between questions

were counted, but participants were not instructed to consider possible contradictions in their responses.

'Yes/no' questions were scored 1 for a correct and 0 for an incorrect response. Justification questions were scored 2 for correct responses (e.g. both feelings were alluded to by the participant when a character experienced mixed emotions), 1 for partially correct responses (e.g. only one feeling was alluded to, but it was either of the appropriate ones experienced by the character) or 0 for an incorrect answer (e.g. no feeling or an inappropriate feeling was alluded to by the participant). Whilst all stories have one 'yes/no' question each, there are three stories with two 'yes/no' questions each. Consequently, a possible total score per vignette was between 0 and 3 or 4, depending on the item. In dividing the SST into two halves, two of the stories were in Half 1 and one story in Half 2. This resulted in the two half-forms having different maximum total scores. As a result, the subsequent analyses were carried out using the percentage of correct responses.

In addition, Response Times were recorded. They were defined as the time between the end of the first presentation of the question and the beginning of a given participant's response. Response times were aggregated into a mean per condition and per participant.

Neuropsychological battery. With this battery, we sought measure general intellectual ability, attention, working memory, verbal memory, and EF in order to characterise the sample and conduct supplementary analyses on the relationships between SST performance and background neuropsychological variables. It has been argued that particular cognitive skills are central to support people's social-cognitive abilities, such as perceiving and attending to social stimuli in the environment, maintaining and monitoring the information held in working memory as well as executive skills including cognitive control and self-regulation (S. McDonald, 2013). Furthermore, our main outcome measure, the SST, and indeed social perceptive abilities such as ToM, rely on a variety of cognitive abilities. We sought to investigate these links further.

Test of Premorbid Functioning (TOPF UK; Wechsler, 2011). The TOPF is a commonly used neuropsychological tool that uses single word oral reading performance to generate an estimate of pre-morbid intellectual ability. Fallows and colleagues (2012) demonstrated that the TOPF possessed good convergent and divergent validity in a sample of patients with mixed neurological impairments.

Matrix Reasoning (MR) from WASI-II UK (Wechsler, 2011b) and Digit Span (DS) from WAIS-IV UK (Wechsler, 2010). This study employed the Matrix Reasoning subtest as an index of perceptual reasoning, as it has good test-retest reliability (r = .86-.94, depending

on the age group) and a strong correlation with the full-scale intelligence quotient (FSIQ, *r* = .75; Sattler & Ryan, 2009, p. 95). Other characteristics that made this subtest suitable for the current study included that it is accessible for people with motor and processing speed difficulties, does not require manual dexterity, and is untimed.

The Digit Span subtest offers good test-retest reliability (*r* = .89-.94, depending on the age group; Sattler & Ryan, 2009, p. 91) and allows for an approximation of a participant's attention span (Forward variant) and working memory more broadly (Forward, Backward , and Sequencing components).

Story Recall (SR) from the Rivermead Behavioural Memory Test-Version 3 (RBMT-3; Wilson et al., 2008). We used the story recall subtest from the RBMT-3 to obtain estimates of verbal memory at immediate and delayed recall intervals. This subtest offers high test-retest reliability (*r* = .85) and interrater reliability of up to 100% (Wilson et al., 1989).

Verbal Fluency (VF; Celis, Kaplan, & Kramer, 2001). The verbal fluency subtest was adopted from the Delis-Kaplan Executive Function System (Celis et al., 2001) and evaluates "the spontaneous production of words under restricted search conditions" (Bechtoldt, Benton, & Fogel, 1962, p. 499). It was used to assess generativity (an aspect of EF), and language via phonemic and semantic trials respectively. Depending on the version, the test offers good internal reliability (*r* = .83) as well as test-retest reliability (r = .74; Bechtoldt et al., 1962).

Trail Making Test (TMT; Reitan, 1958; Reynolds, 2002). The TMT offers a measure of attention, motor speed, and of the task-switching component of EF. The TMT possesses good test-retest reliability (*r* = .79). Part A is reasonably well correlated with Part B (*r* = .31-.36) which also assesses set switching.

Hayling and Brixton tests (Burgess & Shallice, 1997). The Hayling test was used to assess response initiation and the suppression of strongly-cued responses. The Brixton test is considered a measure of rule detection and updating as well as of mental set formation and set shifting. They both offer acceptable split-half consistency (Hayling: *r* = .35-.83; Brixton: *r* = .62) as well as test-retest reliability (Hayling: *r* = .76; Brixton: *r* = .71).

Social cognition and executive function questionnaires. The questionnaires were intended to characterise participants' current level of social and/or executive difficulties in daily life through self-report and if available, through a relative's or carer's responses (with the participant's consent).

BIRT Social Cognition Questionnaire (Cattran et al., 2018). The BSCQ was employed to measure SC deficits. It covers a variety of daily situations which require SC skills. The scale has both self-report and informant versions. It offers high test-retest reliability (r = .94) as well as internal consistency (Cronbach's α = .92). The measure was originally validated in a sample with people affected by ABI.

The Dysexecutive Questionnaire – Revised (Simblett et al., 2017). The DEX-R is a brief measure of executive functioning, including subscales for each of the four domains of PFC function delineated by Stuss and colleagues (2007; 2011b), specifically energising, executive cognitive, emotion and behavioural self-regulation, and meta-cognition. Both self- and informant-rated versions offer good test-retest reliability, r = .88 and r = .60 respectively, and internal consistency, Cronbach's α = .89 (Hellebrekers et al., 2017).

Training Procedure

The instructions for this study were based on the Theory of Mind module of Meta-Cognitive Training for Psychosis and its accompanying manual (Moritz, Woodward, et al., 2013; Moritz, Veckenstedt, et al., 2013). The training has been evaluated in several studies (for a meta-analysis, see Eichner & Berna, 2016), which identified moderate effect sizes for reductions of positive symptoms and delusions in schizophrenia. Small effect sizes remained when only studies with a low risk for bias were included in the meta-analysis. A large effect size was achieved for the acceptance of the intervention, though SC remains to be investigated as a separate outcome variable.

The materials were slightly modified by removing mentions of schizophrenia / psychosis and by referring instead to ABI. The training materials are printed in Appendix 3 [redacted due to picture copyright] and the training instructions (for the examiner) are contained in Appendix 4.

Materials. The content of the Theory of Mind module was shown on a laptop computer screen in a quiet room with a table and chairs for the participant and researcher. Following the guidelines, the investigator ensured that [1] the training was not rushed, [2] that participants felt comfortable to speak their mind, [3] that basic rules of interpersonal engagement were highlighted if necessary (e.g. listening, turn-taking with the researcher), and [4] that a friendly and interactive atmosphere was maintained.

Training. The training was introduced as an exercise to think about social situations. Participants were invited to consider different sources of information which could be socially relevant. This was done using everyday scenarios and examples, told through cartoon strips. Participants were encouraged to attend to the presentation and were told that the full training would take about 20-25 minutes.

The training began by outlining how we may use several sources of information (e.g. eye contact, hand posture, clothes) to evaluate people as well as by enquiring how participants may go about this. The training goes into further detail how language, previous knowledge about a specific person, and our intuition can be important factors in shaping our social judgements. The training continued with an exercise, the overall goal of which was to demonstrate the difference between the facts participants had access to as "omniscient viewers," as opposed to the information available to the stories' protagonists.

Participants were presented with a cartoon with three pictures of a social scenario in which the actors' intentions are ambiguous. The participants were invited to follow along the cartoon pictures and consider what the characters in the story may think about each other. Subsequently, nine more cartoons were presented with four pictures each. The cartoons showed a variety of socially ambiguous or inappropriate situations. Participants were given instructions to try and distinguish between information available to them and to the characters in the stories as well as to consider other possible sources of relevant information. They were also encouraged to consider the questions at the bottom of the cartoons which highlighted conflicting beliefs the actors may have. Participants who struggled to answer these questions appropriately were offered gentle, but consistent corrective feedback.

Experimental Manipulation

In both the 'tally' and the 'strategy' conditions described below, 16 pre-recorded 'bleep' tones were interleaved with prepared recordings of the SST vignettes. This procedure was based on Manly and colleagues (2002) and was chosen to serve as a reminder at least once per story in the 'strategy cue' condition. The timing was pseudo-random to avoid pattern detection, particularly in the 'tally cue' condition. Importantly, the number and spacing of tones per SST half was consistent, regardless of whether the recording was administered under the 'strategy cue' or 'tally cue' condition.

Strategy cue condition. Participants in the 'strategy cue' condition were instructed to read the SST vignettes carefully and answer the comprehension and justification questions to the best of their ability. They were then played an example tone and told, "From

time to time, you may hear a sound being played in the background. Please think back to what you have learned today about ToM and understanding other people's thoughts, feelings, and intentions. When you hear the sound I just played, please try to put yourself in the position of each of the different characters and try to imagine what might be going through their minds before answering the questions. Do you have any questions?" Just before the beginning of the SST, they were reminded, "When you hear the sound, please pay attention to the perspective of each character." Participants were then asked to explain what they were to do when they hear the bleep, to check comprehension of the instructions once more. Any participants who were unable to explain what they needed to do received further instructions until they could show that they understood what they had to do. Non-specific encouragement was provided when necessary, for example if a participant spent more than 60 seconds on a single question after turning the page to the particular story item.

Tally cue control condition. The 'tally cue' condition, the control condition, was identical to the 'strategy cue' condition, with one exception. Instead of the instruction to use the cue as a reminder to employ the ToM strategy, participants were instructed they should make a mark on a tally chart to keep a record how many tones there had been. They were asked to repeat this instruction to confirm comprehension of it before completing the SST. This control task was included because it has face validity (i.e. it is believable that such a task may be included in an experiment or cognitive assessment), and yet has minimal cognitive demands. Other options for control conditions were considered. For example, a 'no tone' condition was considered, but rejected as it did not control for potential alerting or distracting effects of the tone itself. Further, an 'ignore tone' condition was considered, but it was thought that this might be confusing for participants (i.e. it is difficult to develop a plausible cover story), and it also has a lesser cognitive demand relative to the 'strategy cue' condition. The 'tally cue' condition was thought to best balance the auditory and cognitive characteristics of the 'strategy cue' condition, while remaining neutral in relation to the strategy itself. Of course, including more than one control condition would have been informative and useful to disentangle some of the issues mentioned previously. However, there were not enough SST items to allow for more than two experimental conditions and it was pragmatically important to ensure that the experiment could be completed within one session.

At the end of the task, the researcher asked participants what they were meant to do when they had heard the tones to confirm their retention of the experimental instructions. One prompt was provided if a participant failed to recall the instruction accurately. Finally, if the correct answer had still not been given, the participant was asked whether they could recognise the instruction from a set of three multiple choice options.

Procedure

After giving written informed consent and hearing a brief introduction to the study, participants completed the Theory of Mind training module, which lasted approximately 30 minutes.

Participants then completed one half of the SST in either the 'strategy cue' condition or the 'tally cue' condition. The order was counterbalanced as per table 1. The first half of the SST was followed by a break of about 30 minutes before completion of a neuropsychological test battery. The tests were always administered in the following order: TOPF, Hayling test, Story Recall (immediate recall), Matrix Reasoning, Trail-Making Test, Brixton Test, Story Recall (delayed recall), Digit Span, and Verbal Fluency. Participants then completed the other half of the SST under the condition they had not already undergone.

Finally, the BIRT Social Cognition Questionnaire and Dysexecutive Questionnaire-Revised were administered to participants and if available, a significant other. These were given at the end of the study so as not to bias participants (or relatives/carers) with regards to the research questions. Administering the questionnaires was followed by a short debrief including questions to elicit participants' recall of the SST condition instructions and to gather informal qualitative feedback about their experience of the study. Participants were offered information how they will find out about the results of the research as well as to give an opportunity for questions (roughly 15 mins in total).

The entire procedure was estimated to take on average 150 minutes per participant.

Hypotheses

The study focussed on the following hypotheses.

1) Participants' percentage of correct responses will be higher in the 'strategy cue' condition than the 'tally cue' condition (SST Accuracy), indicating effectiveness of the experimental manipulation.
2) Participants who have more executive impairment (based on the background tests) will be more impaired on the SST, showing that the SST is more challenging for them.
3) Participants who have greater EF difficulties will have larger change scores on the SST between 'strategy cue' and 'tally cue' conditions, indicating that they benefit more from the content-free cueing manipulation.

Data Analyses

Participants' demographics were analysed using Student's T and Chi-square tests.

Primary outcome. SST Accuracy was analysed using a 2 x 2 ('strategy cue' versus 'tally cue' x 'strategy cue first' versus 'tally cue first') mixed analyses of variance (ANOVA). Interactions were investigated using Bonferroni-corrected post-hoc comparisons. The third hypothesis was examined using an independent *t*-test.

Supplementary analyses. SST Response Time was analysed in a similar fashion to SST Accuracy. Correlations between changes in SST Accuracy, changes in SST Response Time and participant performance on neuropsychological tests and questionnaire measures were evaluated using linear regression analyses and Pearson's correlations under a family-wise error correction (Keppel & Wickens, 2004). While the Bonferroni error correction is more common, it tends to offer a more conservative adjustment of α-levels, preventing against Type I-errors at the expense of Type-II errors (Armstrong, 2014).

Participants

Forty people were considered for inclusion in the study from a list of current and former clients of the Oliver Zangwill Centre for Neuropsychological Rehabilitation (OZC), an NHS outpatient service in the east of England. All of them were known to have SC difficulties following the centre's standard assessment process. Most clients were identified by clinicians at the OZC service (n = 35) and the remaining ones via a service-user involvement group at the OZC consisting of former clients (n = 5).

Potential participants were considered eligible for the study provided they were [a] aged 18-65 years, [b] had a non-progressive brain injury which [c] had occurred at least 6 months prior, and [d] if they themselves, a relative or a member of their treating team identified SC difficulties. This was operationalised as having, for example, either difficulty seeing things from other people's perspectives, experiencing frequent misunderstandings, struggling to empathise with others or understand their feelings, or having been told by others that their social skills are not as good as they used to be prior to the brain injury. Standardised test scores for measuring such deficits were not used for the criteria as it could not be assumed that these would be available or up-to-date for each client and would have required more extensive access to their medical records. Further inclusion criteria were: [e] the ability and willingness to participate in the 150-minute testing session and [f] adequate English proficiency to enable completion of the assessment battery.

Potential participants were excluded if they [a] had a diagnosed, non-progressive neurodevelopmental condition, as this would likely interfere with their understanding of the

test materials, or [b] had a current estimated IQ < 80, for the same reason, [c] were experiencing an active episode of psychosis, because this could introduce an alternative mechanism by which the participants were experiencing SC difficulties, [d] had alcohol or substance misuse problems at the time of the study or within the previous six months, as these have been linked to a variety of cognitive impairments, [e] if they were unable to attend an appointment at one of the research bases, or lived beyond a 90-minute travelling distance from the principal researcher's base, as this would make it unfeasible to include them, or [f] if referring clinicians or the researcher considered the person to lack mental capacity to consent to participation, in other words to make an informed decision based on the risks and benefits of taking part.

Altogether, sixteen people were excluded from participation the following reasons. Three people were excluded for living outside of the range considered appropriate to travel, and two could not be reached using the available contact details. Two people did not respond to invitations and five people declined due to having other commitments (e.g. working full-time). Three people withdrew following their invitation into the study, but prior to giving written consent: one participant overslept and could not be re-scheduled, one considered the study to require too much effort to participate, and another became unavailable due to a series of minor medical appointments unrelated to their brain injury. A final participant discontinued the study approximately 70% of the way through due to fatigue. Demographic data were not available for people who declined to participate, meaning a sampling bias analysis was not feasible.

The final sample comprised 24 participants. All participants gave written informed consent to take part in this research.

Participant demographics. The participant who was unable to complete the experiment was replaced with another participant at the end of the study who completed the same condition. One participant was allocated to the wrong group (no. 3 instead of no. 2). Hence, the final sample distribution was as follows: group 1 (n = 6), group 2 (n = 5), group 3 (n = 7), group 4 (n = 6). All participants in the final sample completed both the 'tally' and the 'strategy' condition was well as the first and second half of the SST.

Overall, 10 women (41.7%) and 14 men took part in the study. The pre-injury occupational categories (using guidance from Office for National Statistics, 2010) included higher managerial, administrative or professional occupations (n = 2); lower managerial, administrative or professional occupations (n = 6); small employers and own account holders (n = 2); lower supervisory and technical occupations (n = 3); semi-routine occupations (n = 4); routine occupations (n = 4); and never worked or long-term unemployed (n = 3).

Details regarding participants' brain injuries were extracted from assessment reports. Injuries resulted from traumatic brain injury as the result of a road traffic accident (n = 11), traumatic brain injury due to another cause (n = 2), cerebrovascular insult (stroke; n = 5), tumour (n = 3), epilepsy (n = 1), encephalitis (n = 1), and intracranial cyst (n = 1). In terms of the severity of injury, Glasgow Coma Scale (Teasdale & Jennett, 1974) scores for TBI patients ranged from 3 to 15 out of 15, though this was not consistently recorded in assessment reports (n = 8 of 13 participants with TBI, or 61.5%). Loss of consciousness, or coma, was noted in 10 participants (76.9%). In three cases, this was an induced coma. Eight reports cited the presence of post-traumatic amnesia (61.5%).

Demographics expressed as continuous variables are summarised in table 2.

Table 2. Participant demographics.

Table 2

Participant Demographics

Variable	N	Min	Max	Mean/Median	SD	*t**	*p**
Age (in years)	24	24	64	46.3	11.33	0.26	0.80
Education (in years)	23	11	21	14.6	2.80	0.52	0.61
Time since brain injury (in months)	24	19	526	139.3	114.68	0.55	0.59
Glasgow Coma Scale (out of 15)†	8	3	15	11.5	n/a	n/a	n/a
Coma duration (TBI only; days)‡	7	7	49	28.8	17.27	0.20	0.85
Duration of post-traumatic amnesia (TBI only; days)‡	8	6	56	30.5	19.77	0.05	0.96

TBI = traumatic brain injury. * 'Tally condition first' versus 'strategy condition first'. † If two GCS scores were available, the lower was selected. ‡ If the duration of impairment was given as an estimate (e.g. "2-3 weeks"), an average figure was computed (e.g. 17.5 days).

Comparing those who completed the 'strategy cue' condition first to those who completed the 'tally cue' condition first, there were no significant differences between them in terms of gender ($\chi^2(1) = 0.24$, $p = 0.63$), pre-injury occupational category ($\chi^2(6) = 5.54$, $p = 0.48$), type of brain injury ($\chi^2(6) = 5.50$, $p = 0.48$), or the variables listed in table 2. This indicates similar demographic characteristics between groups.

Sample characteristics: cognitive functions. Mean scores for the full sample were in the average range across the domains of pre-morbid intellectual functioning (Test of Premorbid Functioning), an estimate of current intellectual function (Matrix Reasoning subtest), attention and working memory (Digit Span subtest), memory (Story Recall), and EF (Trail Making Test, Verbal Fluency subtest, Hayling and Brixton tests). Outcomes for the battery are summarised in table 3.

Table 3. Standard scores for cognitive function tests.

Table 3

Standard Scores for Cognitive Function Tests

Variables	N	Min.	Max.	Mean	Median	SD
Test of Premorbid Functioning (FSIQ)	24	89	125	106.0	107.0	8.96
Matrix Reasoning (WASI-II)*	24	3	15	11.0	11.5	3.21
Digit Span (WAIS-IV)*	24	2	15	8.9	8.0	3.08
Story Recall (RBMT-3)*						
Immediate	24	1	19	10.7	11.0	4.06
Delayed	24	1	18	9.5	10.0	4.68
Trail Making Test*						
Part A	24	6	13	8.4	7.0	2.36
Part B	24	6	13	8.5	8.5	2.48
Verbal Fluency (D-KEFS)*						
Letters	24	2	18	10.6	12.0	4.43
Categories	24	2	19	10.3	10.0	4.53
Switching	24	2	18	10.0	10.5	3.78
Haying Test**	24	1	8	5.3	6.0	1.66
Brixton Test**	24	4	9	6.7	7.0	1.27

* Scored as scaled score (1-20). ** Scored as Sten score (1-10).

The Full-scale IQ predicted by TOPF is in the average range. Scores on the Matrix Reasoning, Digit Span, Story Recall, Verbal Fluency, Hayling, and Brixton subtests are also in the average range, meaning they are in keeping with the TOPF-predicted FSIQ.

Previously published literature indicates that the scores obtained are common in a group with comparable severity of TBI, the most prominent type of brain injury in this sample, for the TOPF (Joseph et al., 2019), Matrix Reasoning (Ryan et al., 2005), Digit Span (Heinly

et al., 2005), Story Recall (Gallagher & Azuma, 2018), and Verbal Fluency-Category Fluency (Strong et al., 2011).

For the Trail Making Test, participants in the present sample responded more quickly ($Mean_{Part\ A}$ = 41.1±21.27 s; $Mean_{Part\ B}$ = 101.9±76.67 s) compared to another sample with TBI (Periáñez et al., 2007), $Mean_{Part\ A}$ = 70.7±53.1 s, $Mean_{Part\ B}$ = 172.8±113.7 s. However, the latter sample (Periáñez et al., 2007) had likely greater impairments with a lower mean GCS (Mean = 6.7±3.2), roughly ten days longer post-traumatic amnesia (Mean = 42.4±31 days), and significantly average shorter time since injury (Mean = 12.5±10 months). This suggests performance on the Trail Making Test in the current sample was perhaps at the expected level, but response times slower in the comparison sample due to greater neurological impairment. In another comparison study (Strong et al., 2011), the sample scored on average two scaled scores lower on the Letter Fluency and one-and-a-half scaled scores lower on the Category Switching subsections of the Verbal Fluency subtest; the current sample's scores were more in line with the healthy control group. The present sample also made fewer errors on the Brixton test (Draper & Ponsford, 2008) and offered more relevant responses on the Hayling test (S. McDonald et al., 2010) compared to similar samples following TBI. Overall, the present sample ranks comparably with previously published cognitive performance outcomes in participants with ABI regarding estimated pre-morbid IQ, attention, and memory, with some possible strengths in verbal fluency and EF.

Sample characteristics: questionnaires. Scores for the four questionnaires administered as part of this study are summarised in table 4.

Table 4. Total scores for questionnaires.

Table 4

Total Scores for Questionnaires

Variables	N	Min.	Max.	Mean	Median	SD
BIRT Social Cognition Questionnaire*						
Self	24	17	66	38.5	40.0	13.15
Relative	13	14	43	32.3	37.0	10.27
Dysexecutive Questionnaire – Revised**						
Self	24	16	196	72.5	70.0	37.16
Relative	13	29	88	60.5	70.0	22.92

* Higher scores indicate better function. ** Higher scores indicate more problems.

Scores on the BSCQ were lower in the current sample than in another sample of participants with mixed aetiologies of brain injury ($Mean_{Self}$ = 55.7±13.96; $Mean_{Relative}$ = 57.51±16.20). This indicates potentially poorer SC abilities perceived in daily life by both participants and a family member or close other in this study (Cattran et al., 2018). Median scores on the DEX-R were lower for self-report ($Mean_{Self}$ = 51±27) and slightly higher for relative-report ($Mean_{Relative}$ = 66±47) in a sample with a comparable range of presentations (Ford et al., 2016). This shows higher reporting of EF difficulties by participants and slightly lower reporting of EF difficulties by their significant others in this study.

Results

Strange Stories Task

Recall of original instructions. At the end of the study, participants were asked to recall what instruction they had been given under the 'strategy cue' condition. Six participants (three from each condition) were able to recall the correct instruction for the 'strategy condition' at the end of the study (25.0%), i.e., to consider *all* of the characters' perspectives when answering the questions; 12 recalled partially correct instructions (50.0%), e.g. to consider *one* of the characters' perspectives when answering the questions. The six remaining participants recalled incorrect instructions at the end of the study (25.0%),

e.g. that the sound cue was intended to alert them to a section of the story at the time. As it was considered crucial that participants understood and retained the instructions, subsequent analyses are, in the first instance, presented with the latter six participants excluded. This is followed by results representing outcomes for the whole sample.

SST descriptives. Outcomes for the SST with six participants removed are summarised in table 5. Full results are presented subsequently.

Table 5. SST Accuracy and Response Times by order of condition (of those who recalled 'strategy cue' instructions correctly).

Table 5

SST Accuracy and Response Times by Order of Condition (Six Participants Excluded)

Variables	N	Min.	Max.	Mean	Median	SD
Strategy Accuracy	18	45.9%	97.3%	76.0%	73.7%	11.31%
Strategy First	10	45.9%	97.3%	74.4%	72.4%	13.65%
Tally First	8	71.1%	94.7%	78.0%	74.7%	7.92%
Tally Accuracy	18	51.4%	92.1%	74.6%	80.0%	12.59%
Strategy First	10	52.6%	86.5%	74.6%	80.0%	11.38%
Tally First	8	51.4%	92.1%	74.5%	80.0%	14.77%
Strategy Response Time (s)	17*	0.2	5.8	1.7	1.5	1.16
Strategy First	10	1.1	5.8	2.0	1.6	1.38
Tally First	7*	0.2	2.0	1.3	1.4	0.58
Tally Response Time (s)	18	0.2	5.4	2.2	1.8	1.38
Strategy First	10	0.9	5.4	2.1	1.6	1.34
Tally First	8	0.2	4.8	2.4	2.3	1.49

* Time for one participant could not be obtained due to technical error.

Table 6. SST Accuracy and Response Times by condition for the whole group.

Table 6

SST Accuracy and Response Times by Order of Condition (All Participants)

Variables	N	Min.	Max.	Mean	Median	SD
Strategy Accuracy	24	36.8%	97.3%	72.4%	73.4%	13.72%
Strategy First	13	36.8%	97.3%	69.7%	71.1%	16.66%
Tally First	11	59.5%	94.7%	75.7%	73.7%	8.84%
Tally Accuracy	24	51.4%	92.1%	73.4%	78.9%	12.05%
Strategy First	13	52.6%	86.5%	72.6%	78.9%	11.93%
Tally First	11	51.4%	92.1%	74.3%	78.9%	12.73%
Strategy Response Time (s)	23*	0.2	5.8	2.0	1.6	1.18
Strategy First	13	1.1	5.8	2.2	1.7	1.29
Tally First	10*	0.2	4.0	1.6	1.5	1.00
Tally Response Time (s)	24	0.2	8.1	2.6	2.2	1.80
Strategy First	13	0.9	8.1	2.6	1.6	2.08
Tally First	11	0.2	4.8	2.7	2.3	1.50

* Time for one participant could not be obtained due to technical error.

The overall mean accuracy on the SST across conditions was 72.9% (N = 24, Median = 75.4%, SD = 11.20). Gabbatore and colleagues (Gabbatore et al., 2015) previously reported rates of 76.0% (SD = n/a) in a sample of participants with traumatic brain injury, meaning the accuracy achieved by participants in this study is roughly similar. Comparable accuracy rates have also been reported in an earlier study with adults with ventromedial prefrontal lesions (Mean = 75.0%, SD = 23.13%; Geraci & Cantagallo, 2011) and in adolescents with TBI (Mean = 64.2%, SD = 20.75%; Turkstra, Williams, Tonks, & Frampton, 2008). It is worth acknowledging that previous studies have used different scoring criteria for the SST, such as counting the response to the first comprehension only but not to the justification question, e.g. in the case of Turkstra and colleagues (2008).

Hypothesis testing 1: Accuracy. The first hypothesis stated that SST Accuracy would be higher in the 'strategy condition' than in the 'tally condition'. This hypothesis was examined using a mixed ANOVA with 2 ('tally condition' versus 'strategy condition') x 2 ('tally condition first' versus 'strategy condition first') factors using participants' SST Accuracy scores. There was no main effect of condition, $F(1, 16) = 0.24$, $p = 0.63$, and there was no

significant interaction effect, $F(1, 16) = 0.30$, $p = 0.59$. Note that the results were comparable when participants who had provided incorrect responses were included; $F(1, 22) = 0.08$, $p = 0.78$, interaction $F(1, 22) = 0.68$, $p = 0.42$.) This finding indicates, contrary to the hypothesis, that there was no significant advantage in participants' accuracy based on the 'strategy cue' over the 'tally cue' experimental manipulation.

Hypothesis testing 2: Executive function A. The second hypothesis stated that participants who have more executive impairment (as measured by the Trail Making, Brixton, and Hayling tests) will be more impaired on the SST. For the purpose of this analysis, Hayling, Brixton, and Trail Making Test scores were first transformed into percentages, as the former were expressed in standard and the latter in Sten scores. Then, a mean percentage was computed based on the outcome of all three tests (without those who incorrectly recalled instructions [$n_{EF} = 18$]: $M_{EF} = 49.2\%$, $SD_{EF} = 6.97\%$; with those participants included [$n_{EF} = 25$]: $M_{EF} = 48.4\%$, $SD_{EF} = 6.63\%$). SST scores were averaged across the two conditions (without those who incorrectly recalled instructions [$n_{SST} = 18$]: $M_{SST} = 75.3\%$, $SD_{SST} = 9.80\%$; with those participants included [$n_{SST} = 24$]: $M_{SST} = 72.9\%$, $SD_{SST} = 11.20\%$).

With six participants excluded, the correlation between executive functioning performance and participants' score on the SST was not significant (n = 18, $r = -0.09$, $p = 0.72$). With those participants included, the correlation was also not significant (n = 24, $r = 0.02$, $p = 0.92$).

Hypothesis testing 3: Executive function B. The third hypothesis stated that participants with lower EF would experience a greater benefit by content-free cueing in the accuracy of their SST responses. The mean score of the Trail Making, Brixton, and Hayling tests was used to split the sample in two halves using the median (Median = 49.7%; lower half [n = 9]: M = 43.7%, SD = 4.64%; upper half [n = 9]: 54.6%, SD = 3.86%). Based on the full sample, the percentages in the two halves were as follows, lower half (n = 12): M = 43.5%, SD = 5.04%; upper half (n = 12): M = 53.5%, SD = 3.83%.

With six participants excluded, there was no significant difference in the change score on SST Accuracy between those in the lower (n = 9, M = 0.7%, SD = 13.87%) and those in the upper half (n = 9, M = 2.1%, SD = 14.41%) of EF performance, using the percentage across the Hayling, Brixton, and Trail Making Tests; $t(16) = -0.21$, $p = 0.84$. The same was true with all participants included (lower half: n = 12, M = -2.3%, SD = 13.19%; upper half: n = 12, M = 0.4%, SD = 12.95%); $t(22) = 0.49$, $p = 0.63$.

Supplementary Analyses

Given the limited findings regarding the study's primary hypotheses, supplementary analyses were conducted in order to investigate interactions between the primary outcomes and response time/self-report measures as well as to explore possible alternative explanations for null findings. It is important to hold in mind that the subsequent analyses were exploratory and likely under-powered.

Response times. Following the hypothesis-driven analyses, it was important to consider how the experimental manipulation might affect participants' response times. This is because there was no significant difference in participants' accuracy depending on condition, but differences in response time may represent a speed/accuracy trade-off (Förster et al., 2003; Perri et al., 2014). This concept was examined using a mixed factorial ANOVA with 2 ('tally condition' versus 'strategy condition') x 2 ('tally condition first' versus 'strategy condition first') using participants' SST response times. With six participants excluded, both the main effect of condition was significant, $F(1, 15) = 6.18$, $p = 0.03$, $\eta^2 = 0.29$, as was the interaction effect, $F(1, 15) = 5.99$, $p = 0.03$, $\eta^2 = 0.29$. The effect size indicates that 29% of the variance can be explained both by allocation to the 'strategy cue'/'tally cue' conditions as well as in which order participants completed the conditions. More specifically, participants who underwent the 'tally cue' condition first gave their responses ca. 0.46 s slower in the 'tally cue' condition and ca. 0.75 s faster in the 'strategy cue' condition, $t(6) = 2.77$, $p = 0.03$. For the participants who completed the 'strategy cue' condition first, this difference was not significant, $t(9) = 0.04$, $p = 0.97$.

With the six participants included, results indicated a main effect of condition, $F(1, 21) = 5.56$, $p = 0.03$, $\eta^2 = 0.21$. The interaction term was not significant, $F(1, 21) = 1.55$, $p = 0.23$. Neither was there a main effect of condition order, $F(1, 21) = 0.07$, $p = 0.79$. The effect size means that 21% of the variance is explained by assignment to the 'strategy cue'/'tally cue' conditions. This finding, in contrast to the first set of results, suggests that there was a significant difference in response times between participants completing the 'tally cue' and 'strategy cue' conditions, and that this was not dependent on whether the 'tally cue' or 'strategy cue' condition was completed first. The average response time in the 'strategy cue' condition was 1.95 s (SD = 1.18) and 2.70 s (SD = 1.82) in the 'tally cue' condition. This means participants during the 'strategy condition' responded on average 0.74 s quicker compared to during the 'tally condition' in this set of analyses.

Correlations: pre-morbid function. It is possible that differences in accuracy or response time performance between the strategy and tally conditions were related to pre-morbid intelligence (Donders & Stout, 2018; O'Neil et al., 2013). The relationship between

estimated pre-morbid intellectual function, assessed using the Test of Premorbid Function (TOPF; Wechsler, 2011), and differences in SST Accuracy and SST Response Time between 'strategy cue' and 'tally cue' conditions was examined using Pearson's correlations. For this purpose, SST Accuracy in the 'tally cue' condition was subtracted from that in the 'strategy cue' condition (with an analogous procedure for SST Response Time). Four correlations being computed resulted in an adjusted α rate of 0.01 (Šidák, 1967).

With six participants excluded, participants' pre-morbid intellectual function, as expressed through the TOPF full-scale IQ estimate, was not significantly correlated with participants' change in SST Accuracy, $p = 0.33$, or SST Response Time, $p = 0.30$. With all 24 participants included, neither the correlation between TOPF IQ estimate and SST Accuracy was significant, $p = 0.11$, or the correlation with SST Response Time, $p = 0.24$.

Correlations: executive function. In order to investigate the relationships between SC performance on the SST and EF on the neuropsychological test battery, stepwise regression analyses were conducted. As opposed to Pearson correlations, the output from regression analyses would offer an overview of the relative contributions of the independent variables to the regression equation, given that the overall model is significant. The following standard scores were entered as independent variables: Hayling Test, Story Recall-immediate, Story Recall-delayed, Matrix Reasoning, Trail Making Test-part A, Trail Making Test-part B, Brixton Test, Digit Span, Verbal Fluency-letters, Verbal Fluency-categories, and Verbal Fluency-switching. As dependent variables served: percentage change in SST Accuracy or SST Response Time across 'strategy cue' and 'tally cue' conditions.

Using the difference in percentage correct responses (SST Accuracy) between 'strategy cue' and 'tally cue' condition as the dependent variable while six participants were excluded from this analysis, no other variable was entered into the regression equation as none of the individual correlations were significant. The same was true when the difference in SST Response Time between 'strategy cue' and 'tally cue' conditions served as independent variable, or when the remaining six participants' figures were entered into either equation.

Correlations: questionnaires. Changes in SST Accuracy and SST Response Times were correlated with the BSCQ and DEX-R self- and relative-report measures. This was done in order to investigate the relationship between task performance and measures of day-to-day SC and EF ability. The adjusted α was 0.003 (Šidák, 1967). None of the correlations were significant at this threshold or at the uncorrected threshold of $\alpha = 0.05$. This means that changes in SST Accuracy and Response Times between 'strategy cue' and

'tally cue' conditions were not significantly correlated with questionnaire measures of EF or SC ability as reported by participants or their significant others.

Participant feedback. Participants (n = 24) completed the study on average in 2 h 35 min (SD 18 min; incl. lunch break: 3 h 5 min, SD 20 min). This was in keeping with the original estimate of 2 h 30 min.

Regarding the participants' time and effort, eight participants gave positive feedback or asked interested questions about the study (32.0% out of n = 25%), e.g. requesting a summary of the eventual findings of the research. However, four participants (16.0%) gave negative feedback, including the participant who discontinued the study. The person raised concerns about the length of the experiment and would have preferred more breaks, though the instructions indicated that the person could take as many breaks as they liked and all requests for breaks were granted. Another participant voiced a concern about breaks, though found some tasks too easy; one participant noticed criticising themselves a lot regarding their performance on the tasks, and the remaining participant found the testing room too warm. Ten participants (40.0%) offered no feedback or questions; three responses (12.0%) were missing. Out of those who were asked (n = 20), every participant agreed at the end of the study that they would respond back if they were invited to take part in this type of project again (100.0%). Overall, this suggests that participants generally had a positive experience of the study and considered their investment of time and energy worthwhile.

Discussion

Summary of Findings

This study investigated whether, following a short perspective-taking training, content-free cueing could enable people with social-cognitive problems after an acquired brain injury to make more accurate social inferences on a theory of mind task. All participants completed a 'strategy cue' condition, whereby they were prompted to apply the perspective-taking skills in response to the content-free cue. Participants also completed a 'tally cue' condition during which they had been instructed to merely count the occurrence of content-free cues. Contrary to the first hypotheses, there was no significant accuracy benefit for participants under the 'strategy cue' condition as opposed to 'tally cue' condition over the course of completing the ToM task. Not in keeping with the second hypothesis, there was no significant correlation between participants' performance on measures of executive functioning and their score on the SST. Also contrary to hypothesis three, participants with poorer EF did not significantly benefit from the content-free cueing in terms of the accuracy

of their SC performance compared to those with higher EF in the present sample, based on a median-split analysis.

In terms of supplementary analyses, the 'strategy cue' condition did confer participants a benefit in terms of response time, but only when participants completed it after the 'tally cue' condition. This meant that condition order played a significant role. Previous research has shown that people after ABI may experience difficulties in task-monitoring (Chiou et al., 2011; Larson et al., 2011, 2012; Zhao et al., 2018). Perhaps the repetition of the cue in the 'strategy' following the 'tally' condition, or the motor action of ticking a box when this cue occurred, served as a prompt for more successful internal monitoring for participants (Hewitt et al., 2006).The difference in accuracy and response time performance between conditions was not significantly correlated with an estimated measure of pre-morbid intelligence, standardised measures of EF, memory, and attention or questionnaire measures of EF or SC abilities as reported by participants or someone who knows them well. Finally, participants found their effort and time expended on the research worthwhile and expressed willingness to engage with similar studies in future.

The effectiveness of content-free cueing has been demonstrated previously for executive abilities in participants after ABI (Fish et al., 2007; Manly et al., 2002, 2004). Concurrently, it has been shown that participants with ABI respond favourably to rehabilitation of SC abilities (Cassel et al., 2019; Kelly et al., 2017a; Manly & Murphy, 2012; Vallat-Azouvi et al., 2019; Westerhof-Evers et al., 2017). In a study on social-communicative abilities, participants with ABI undertook 15 sessions of a 'Cognitive Pragmatic treatment' which included communicative (e.g. conversational abilities, non-verbal skills) and cognitive (e.g. problem-solving, ToM) skills (Gabbatore et al., 2015). Though participants showed some improvement in communication abilities on the ABaCo as well as in some cognitive abilities (immediate and delayed recall, Wisconsin Card Sorting Test) after training, there was no significant improvement in SC as measured by the Strange Stories and Sally & Ann tasks. If rehabilitation aimed at strengthening a SC skill (social communication or here, content-free cueing of social perspective-taking) does not produce a measurable effect on a SC outcome measure (e.g. SST), it warrants consideration of the insufficient matching between the two.

Slower processing speed is a potential deficit in those affected by ABI (Winardi et al., 2014) and has been demonstrated across a variety of standardised cognitive tests (Dymowski et al., 2015). Research in this area suggests that reduced processing speed is linked with EF difficulties, and may relate to people struggling to interrupt their current activity to re-evaluate (Dymowski et al., 2015) or to shift between competing task requirements (Muir et al., 2015). Consequently, the 'strategy cue' may have conferred participants a benefit in evaluating their responses or in focussing their attention on task-

relevant information. However, the finding of reduced response times must be interpreted with caution, as participants had not been instructed to respond as quickly as possible and response time improvements were only found when the 'strategy cue' condition was second to the 'tally cue' condition.

Limitations

As a null result, the finding of no significant difference in accuracy between conditions is difficult to interpret. There are several possibilities why an effect was not found. It is conceivable that the study was underpowered in terms of sample size, particularly as one participant was excluded due to fatigue and another participant was administered conditions in the wrong order. However, the sample size was based on an expected medium effect size and was overall in line with comparable studies (Martín-Rodríguez & León-Carrión, 2010).

A somewhat surprising finding was the lack of correlations between participants' measures of executive functioning and their performance on the SST, and that participants with poorer executive functioning did not benefit more greatly from the instruction under the strategy condition. It is known that social cognition and executive functioning are associated (Manly & Murphy, 2012; Struchen et al., 2008; Westerhof- Evers et al., 2019). It is difficult to establish possible causes in comparison to the related literature for correlation analyses under the second hypothesis, as the SST scores for the 'strategy cue' and 'tally cue' conditions were collapsed into on measure. This means performance on the SST could not be examined in isolation. In the case of correlation analyses under the third hypothesis, EF measures produced a good range (n = 25, 33.3-62.2%). One contributor to the lack of significant findings is conceivably that the experimental manipulation ('strategy cue' versus 'tally cue' instructions) was not sufficiently impactful to support participants' with executive function difficulties.

It is important to consider participants characteristics when evaluating the findings of this study. It has been demonstrated that chronological age (Flanagan et al., 2005), age at injury (Johnson & Stewart, 2015), time since injury (Katz et al., 2009; McCrea et al., 2009; Povlishock & Katz, 2005), and injury severity (Matheson, 2010; Van Baalen et al., 2003) can have an impact on cognitive performance. Overall, the present sample had significant variability in terms of participants' ages (24-64 years) when attending the study, time since injury (19-526 months), and injury severity (Glasgow Coma Scale scores 3-15). Based on existing findings, it would be expected that younger participants and those who were younger at the time of their brain injury as well as participants who had less time elapsed since the brain injury and who endured less severe cerebral insults may have greater

cognitive resilience and demonstrate greater benefits from social cognitive rehabilitation compared to older participants and those who were older at the time of injury, who had significantly more time elapsed since the brain injury and who suffered more severe cerebral insults (Flanagan et al., 2005; Johnson & Stewart, 2015; Katz et al., 2009; McCrea et al., 2009).

Six participants were unable to recall the instructions for the 'strategy cue' condition at the end of the study. It is possible that they were able to apply the instructions at the time, as they were given immediately before the phase when they were needed, the instructions were repeated at least once per participants (and more on request), and participants were given an opportunity to ask any questions. However, participants' verbal representation of the instructions, to assess their understanding, was not explicitly recorded at the time.

A further limitation was that participants' presentations were defined to include various aspects of SC (Henry et al., 2016). It is conceivable that more stringent criteria around SC difficulties may have produced clearer results, though there is currently no gold standard for the assessment of SC (e.g. Milders, 2019). Criteria were kept broad in order to involve participants with a variety of difficulties with the aim of maximising representativeness (Bezeau & Graves, 2001). In addition, the study sought to recruit participant numbers to be suitably powered. As this study was focussed on using an executive strategy (content-free cueing) to support SC difficulties, selecting participants with known EF impairments may have demonstrated greater effectiveness of the intervention (Theadom et al., 2019; Westerhof- Evers et al., 2019).

Participants in both conditions completed the perspective-taking training included in this study and it served as the material for them to cast their minds back to during the 'strategy cue' condition. The training was explicitly chosen to focus on the ToM element of SC and in order to fit into an envisaged time frame that would be manageable for participants after ABI. However, SC encompasses a variety of components, including empathy, social perception, and social behaviour (Henry et al., 2016). Even though participants engaged well with the training in this study, a more targeted training according to participants' needs may have produced a larger effect. In addition, the training employed in the current research lasted approximately 30-45 mins whereas training in other studies was designed between 6-25 hours (Cassel et al., 2019). Therefore, it is conceivable that more intensive training could also have produced a more significant impact on participants' ability for perspective-taking. However, this level of training would not have been feasible in the doctoral research context while maintaining a comparable sample size.

Accuracy on the SST ranged between 36.8% to 97.3% with medians of 78.9% in the 'strategy cue' and 73.0% in the 'tally cue' condition, meaning most participants scored quite highly. This was despite participants not being given a practice item, feedback about their

responses or being asked follow-up questions to clarify any responses. This was in keeping with the original design of the measure (Happé, 1994). Perhaps a more stringent assessment of perspective-taking abilities and subtleties of social interaction, such as the Faux Pas Test (Baron-Cohen et al., 1999), would have been able to crystallise the difference between conditions more starkly (Fazaeli et al., 2018; Milders et al., 2003).

Furthermore, it is valuable to consider any systematic recruitment biases in order to appropriately evaluate the representativeness of the present findings. The study, by its design, made requirements of the participants in terms of time and being able to travel. Of the 15 excluded participants, four declined due to working full-time and four lived too far away from the recruitment sites to participate. This may have introduced a bias in terms of sampling a representative group of people with ABI, though no demographic data were recorded of excluded participants to investigate further.

Directions for Future Research

As outlined above, future research in this area may benefit from ensuring participants have accurately understood the instructions related to the strategy by asking them to repeat the directions, or requesting that they record them in writing. The aim of this would be to facilitate accurate retention of instructions, an approach taken in similar previous studies (e.g. Manly et al., 2002; Fish et al., 2007). In addition, not only may a longer training be more effective, but also one that is potentially geared towards participants' SC needs. This would need balancing against participants' ability to travel or attend, perhaps by offering portions of the training online for them to access with greater flexibility. Moreover, measures of SC other than the SST may be more sensitive to picking up group difference in how characters' perspectives are perceived following impairments resulting from ABI.

In addition, previous reviews in the area have made recommendations for best practice (Finch et al., 2016; Mogensen & Wulf-Andersen, 2017; Togher et al., 2014). Specifically, the authors have argued that SC research situate treatment in naturalistic contexts, ideally with relevant communication partners, and clearly specify treatment components for improvement, maintenance and generalisation. They have also argued that the chronic phase of recovery would be a suitable time to target. The present study included participants in the chronic phase of recovery, employed somewhat naturalistic examples, and set out a clear intervention target. However, a revised study with more detailed SC goals, more specific measurement of SC performance, and increased focus on supporting participants' cognitive needs could likely address the above aims more accurately.

Implications for Clinical Practice

The clinical implications from this study are limited due to the lack of support for the original hypotheses. In a recent review focussing particularly on social communication, Meulenbroek and colleagues (2019) have argued that treatment following ABI is reliant on current theory (e.g. theoretical components of SC). However, interventions need breaking down into treatment targets (e.g. performance criteria, such as improved sarcasm detection), mechanisms of action (e.g. hypothesized process of change, such as rehearsal), and treatment ingredients (e.g. clinician actions on client/environment, such as treatment length and intensity). One approach which incorporates these components is the Rehabilitation Treatment Specification System (RTSS; Van Stan et al., 2019) which is regularly updated. In this way, it allows clinicians go beyond 'off-the-shelf' interventions according to diagnoses or presentations. Instead, clinicians can select treatment components based on their

assessment, the client's needs, and social context while keeping with the available evidence base.

Clinical interventions also need to consider clients' cognitive deficits in order to allow them to make appropriate use of rehabilitation. This requires careful assessment, consideration of relevant contexts for a cognitive task, and detailed goal planning (Wilson, 2008). Adaptations may, for example, include offering planning strategies for clients with executive dysfunction (B. C. McDonald et al., 2002), self-monitoring skills for attentional difficulties (Ownsworth & Fleming, 2005) or as in the present case, sufficient repetition and checking of understanding for clients with memory difficulties (Levine et al., 1998; Wilson, 2008).

Cueing has been found to be a useful adjunct in supporting cognitive rehabilitation after brain injury. Richard and colleagues (2018) demonstrated the benefit of an audio cue for improved performance on a sustained attention task in an fMRI scanner for participants with TBI. The cue was associated with the instruction to re-orient to the task at hand. Tornås and colleagues (2016) sent 'STOP' text messages to their participants as prompts to apply CBT and mindfulness techniques. This resulted in self-reported improvements in emotion regulation and quality of life, though not in emotional distress. Hewitt and colleagues (2006) employed cueing of autobiographical memories to support the ability of participants with EF difficulties after TBI to improve their task planning performance. Evidence is consolidating that cueing is an effective and versatile tool in supporting clients' cognitive abilities after ABI.

Rehabilitative interventions for SC also require careful selection of outcome measures. While a variety of tools are available, they do not always cover the full spectrum of clients' socio-emotional difficulties after brain injury (Hynes et al., 2011). Concerns also remain about the standardisation of assessment tools in the face of mounting availability of evidence-based social-cognitive rehabilitation programs (Driscoll et al., 2010; Kelly et al., 2017a). Future research intended for clinical application will have to consider a common set of SC measures to allow comparability across studies, include ratings above and beyond beyond self-report as well as measure behavioural outcomes that are linked to social-cognitive performance (Milders, 2019).

Conclusions

Social cognition impairments have a significant effect on people's interpersonal and emotional well-being. This study investigated the efficacy of a content-free cueing paradigm in supporting adults with social cognition difficulties after acquired brain injury. In the experimental 'strategy cue' condition, the cue was intended to serve as a reminder of a short earlier training about social inferences. Participants' answers on a theory of mind task were

not significantly more accurate, but they responded roughly 0.75 s more quickly compared to the control ‘tally cue’ condition. However, this was only the case when participants completed the ‘strategy cue’ condition after the ‘tally cue’ condition. Despite the lack of support for the original hypotheses, cueing and social cognition interventions stand on their own respective merit as rehabilitation techniques. This remains a fruitful and important area for future clinical research.

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Appendix 1 – HRA Approval

Dr Patrick Smith
Clinical Psychologist
King's College London & South London and Maudsley NHS Foundation Trust

King's College London, Institute of Psychiatry, Psychology & Neuroscience
PO78, De Crespigny Park
London
SE5 8AF

Email: hra.approval@nhs.net
Research-permissions@wales.nhs.uk

24 October 2018

Dear Dr Smith

HRA and Health and Care

Study title:	**The effects of a combined intervention targeting executive function and theory of mind on social inference in people with acquired brain injury**
IRAS project ID:	**248547**
Protocol number:	**N/A**
REC reference:	**18/LO/1762**
Sponsor	**King's College London**

I am pleased to confirm that **HRA and Health and Care Research Wales (HCRW) Approval** has been given for the above referenced study, on the basis described in the application form, protocol, supporting documentation and any clarifications received. You should not expect to receive anything further relating to this application.

How should I continue to work with participating NHS organisations in England and Wales? You should now provide a copy of this letter to all participating NHS organisations in England and Wales, as well as any documentation that has been updated as a result of the assessment.

Following the arranging of capacity and capability, participating NHS organisations should **formally confirm** their capacity and capability to undertake the study. How this will be confirmed is detailed in the "*summary of assessment*" section towards the end of this letter.

You should provide, if you have not already done so, detailed instructions to each organisation as to how you will notify them that research activities may commence at site following their confirmation of capacity and capability (e.g. provision by you of a 'green light' email, formal notification following a site initiation visit, activities may commence immediately following confirmation by participating organisation, etc.).

It is important that you involve both the research management function (e.g. R&D office) supporting each organisation and the local research team (where there is one) in setting up your study. Contact details of the research management function for each organisation can be accessed here.

How should I work with participating NHS/HSC organisations in Northern Ireland and Scotland?

HRA and HCRW Approval does not apply to NHS/HSC organisations within the devolved administrations of Northern Ireland and Scotland.

If you indicated in your IRAS form that you do have participating organisations in either of these devolved administrations, the final document set and the study wide governance report (including this letter) has been sent to the coordinating centre of each participating nation. You should work with the relevant national coordinating functions to ensure any nation specific checks are complete, and with each site so that they are able to give management permission for the study to begin.

Please see IRAS Help for information on working with NHS/HSC organisations in Northern Ireland and Scotland.

How should I work with participating non-NHS organisations?

HRA and HCRW Approval does not apply to non-NHS organisations. You should work with your nonNHS organisations to obtain local agreement in accordance with their procedures.

What are my notification responsibilities during the study?

The document "*After Ethical Review – guidance for sponsors and investigators*", issued with your REC favourable opinion, gives detailed guidance on reporting expectations for studies, including: Registration of research

- Notifying amendments
- Notifying the end of the study

The HRA website also provides guidance on these topics, and is updated in the light of changes in reporting expectations or procedures.

I am a participating NHS organisation in England or Wales. What should I do once I receive this letter?

You should work with the applicant and sponsor to complete any outstanding arrangements so you are able to confirm capacity and capability in line with the information provided in this letter.

The sponsor contact for this application is as follows:

Name: Professor Reza Razavi

Tel: 0207 8483224

Email: reza.razavi@kcl.ac.uk

Who should I contact for further information?

Please do not hesitate to contact me for assistance with this application. My contact details are below.

Your IRAS project ID is **248547**. Please quote this on all correspondence.

Yours sincerely

Rekha Keshvara

Senior Assessor

Email: hra.approval@nhs.net

Copy to: *Professor Reza Razavi*
Ms Paula Waddingham, Cambridgeshire Community Services

List of Documents

The final document set assessed and approved by HRA and HCRW Approval is listed below.

Document	*Version*	*Date*
Covering letter on headed paper [Covering Letter]	1.0	17 September 2018
Evidence of Sponsor insurance or indemnity (non NHS Sponsors only) [Evidence of Sponsor Indemnity]	1.0	17 September 2018
Evidence of Sponsor insurance or indemnity (non NHS Sponsors only) [Evidence of Sponsor Indemnity]	2.0	20 July 2018
HRA Schedule of Events	1	24 October 2018
HRA Statement of Activities	2	24 October 2018
IRAS Application Form [IRAS_Form_26092018]		26 September 2018
IRAS Application Form XML file [IRAS_Form_26092018]		26 September 2018
IRAS Checklist XML [Checklist_08102018]		08 October 2018
IRAS Checklist XML [Checklist_26092018]		26 September 2018
Letter from funder [Letter from Funder]	1.0	24 January 2018
Letter from sponsor [Letter from Sponsor]	2.0	26 September 2018
Letter from sponsor [Letter from Sponsor]	1.0	17 September 2018
Letter from statistician [Letter from Statistician]	1.0	24 September 2017
Letters of invitation to participant [Letter of Invitation to Participants]	1.0	06 August 2018
Other [Evidence of Sponsor Insurance (non-NHS Sponsors only)]	2.0	01 August 2018
Other [Evidence of Sponsor Insurance (non-NHS Sponsors only)]	2.0	09 July 2018
Other [Summary CV for Supervisor (2/2)]	1.0	15 June 2018
Other [Validated questionnaire - BIRT SCQ (Self-rating)]	1.0	17 August 2018
Other [Validated questionnaire - DEX-R (Self-rating)]	1.0	17 August 2018
Other [Evidence of Sponsor Insurance (non-NHS Sponsors only)]	1.0	01 August 2018
Other [Evidence of Sponsor Insurance (non-NHS Sponsors only)]	1.0	09 July 2018
Participant consent form [Patient Consent Form]	1.0	17 September 2018
Participant information sheet (PIS)	1.1	19 October 2018
Referee's report or other scientific critique report [Referee Report]	V1.0	19 January 2018
Research protocol or project proposal [Research Protocol]	1.0	25 September 2018
Summary CV for Chief Investigator (CI) [CV for Chief Investigator]	1.0	04 September 2018
Summary CV for student [Summary CV for Student]	1.0	05 July 2018
Summary CV for supervisor (student research) [Summary CV for Supervisor (1/2)]	1.0	21 May 2018
Summary, synopsis or diagram (flowchart) of protocol in non technical language [Synopsis of Protocol in Non-technical Language]	1.0	17 September 2018
Validated questionnaire [Strange Stories Task (SST)]	1.0	02 July 2018

Summary of assessment

The following information provides assurance to you, the sponsor and the NHS in England and Wales that the study, as assessed for HRA and HCRW Approval, is compliant with relevant standards. It also provides information and clarification, where appropriate, to participating NHS organisations in England and Wales to assist in assessing, arranging and confirming capacity and capability.

Assessment criteria

Section	Assessment Criteria	Compliant with Standards	Comments
1.1	IRAS application completed correctly	Yes	No comments
2.1	Participant information/consent documents and consent process	Yes	The patient information sheet was updated post REC favourable opinion to bring it in line with the HRA standards.
3.1	Protocol assessment	Yes	No comments
4.1	Allocation of responsibilities and rights are agreed and documented	Yes	A statement of activities has been submitted and the sponsor is not requesting and does not expect any other site agreement to be used.
4.2	Insurance/indemnity arrangements assessed	Yes	No comments
4.3	Financial arrangements assessed	Yes	As per the statement of activities there are no funds being provided to the sites by the sponsor
5.1	Compliance with the Data Protection Act and data security issues assessed	Yes	No comments
5.2	CTIMPS – Arrangements for compliance with the Clinical Trials Regulations assessed	Not Applicable	No comments
5.3	Compliance with any applicable laws or regulations	Yes	No comments

6.1	NHS Research Ethics Committee favourable opinion	Yes	No comments
Section	**Assessment Criteria**	**Compliant with Standards**	**Comments**
	received for applicable studies		
6.2	CTIMPS – Clinical Trials Authorisation (CTA) letter received	Not Applicable	No comments
6.3	Devices – MHRA notice of no objection received	Not Applicable	No comments
6.4	Other regulatory approvals and authorisations received	Not Applicable	No comments

Participating NHS Organisations in England and Wales

This provides detail on the types of participating NHS organisations in the study and a statement as to whether the activities at all organisations are the same or different.
This is a single site study and therefore, there is only one site-type. The Chief Investigator or sponsor should share relevant study documents with participating NHS organisations in England and Wales in order to put arrangements in place to deliver the study. The documents should be sent to both the local study team, where applicable, and the office providing the research management function at the participating organisation. Where applicable, the local LCRN contact should also be copied into this correspondence. If chief investigators, sponsors or principal investigators are asked to complete site level forms for participating NHS organisations in England and Wales which are not provided in IRAS, the HRA or HCRW websites, the chief investigator, sponsor or principal investigator should notify the HRA immediately at hra.approval@nhs.net or HCRW at Research-permissions@wales.nhs.uk. We will work with these organisations to achieve a consistent approach to information provision.

Principal Investigator Suitability

This confirms whether the sponsor position on whether a PI, LC or neither should be in place is correct for each type of participating NHS organisation in England and Wales, and the minimum expectations for education, training and experience that PIs should meet (where applicable).
A Principal Investigator is expected to be in place at the participating site GCP training is not a generic training expectation, in line with the HRA/HCRW/MHRA statement on training expectations.

HR Good Practice Resource Pack Expectations

This confirms the HR Good Practice Resource Pack expectations for the study and the pre-engagement checks that should and should not be undertaken
Use of identifiable patient records held by an NHS organisation to identify potential participants should be undertaken by a member of the direct care team for the patient, so it would not normally be acceptable for this to be done by staff not employed by that organisation. A Letter of Access Contract (or equivalent) would be expected for any external NHS/research staff undertaking all of the other activities for the study once consent from the participant is in place. The pre-engagement checks should include standard DBS check and Occupational Health Clearance.

Other Information to Aid Study Set-up

This details any other information that may be helpful to sponsors and participating NHS organisations in England and Wales to aid study set-up.
The applicant has indicated that they do not intend to apply for inclusion on the NIHR CRN Portfolio.

Appendix 2 – Strange Stories Task

SST Instructions – Half 1

Table 1

Administration Order

Participant Number	Part 1 of Session 1	Part 2 of Session 1
1, 5, 9, 13, 17, 21;	Tally condition, SST half 1	Strategy condition, SST half 2
2, 6, 10, 14, 18, 22;	Tally condition, SST half 2	Strategy condition, SST half 1
3, 7, 11, 15, 19, 23;	Strategy condition, SST half 1	Tally condition, SST half 2
4, 8, 12, 16, 20, 24.	Strategy condition, SST half 2	Tally condition, SST half 1

**** Start recording ****

Strategy Condition: "Here are some stories and some questions."

"I'm going to read out the stories and I'd like you to listen carefully,
and help me with the questions at the end of each story."

"From time to time, you may hear a sound being played in the background. **** play audio sample **** Please think back to what you have learned today about theory of mind and understanding other people's thoughts, feelings, and intentions. When you hear the sound I just played, please try to put yourself in the position of each of the different characters and try to imagine what might be going through their minds before answering the questions. Do you have any questions?"

"When you hear the sound, please pay attention to the perspective of each character."

Tally Condition: "Here are some stories and some questions."

"I'm going to read out the stories and I'd like you to listen carefully,
and help me with the questions at the end of each story."

"From time to time, you may hear a sound being played in the background. **** play audio sample **** When you hear the sound I just played, please make a mark on this sheet to keep a record how many tones there have been. Do you have any questions?"

"When you hear the sound, please make a mark on the sheet in front of you."

**** Start audio cues ****

2.

Jane and Sarah are best friends. They both entered the same painting competition. Now Jane wanted to win this competition very much indeed, but when the results were announced it was her best friend Sarah who won, not her. Jane was very sad she had not won, but she was happy for her friend, who got the prize. Jane said to Sarah, “Well done, I’m so happy you won!” Jane said to her mother, “I’m sad I didn’t win that competition!”

Q. Is it true what Jane said to Sarah?

Q. Is it true what Jane said to her mother?

Q. Why does Jane say she is happy and sad at the same time?

3.

Sarah and Tom are going on a picnic. It is Tom's idea, he says it is going to be a lovely day for a picnic. But just as they are unpacking the food, it starts to rain, and soon they are both soaked to the skin. Sarah is cross. She says, "Oh yes, a lovely day for a picnic all right!"

Q. Is it true, what Sarah says?

Q. Why does she say that?

5.

Today James is going to Claire's house for the first time. He is going over for tea, and he is looking forward to seeing Claire's dog, which she talks about all the time. James likes dogs very much. When James arrives at Claire's house, Claire runs to open the door, and her dog jumps up to greet James. Claire's dog is huge, it's almost as big as James! When James sees Claire's huge dog he says, "Claire, you haven't got a dog at all. You've got an elephant!"

Q. Is it true, what James says?

Q. Why does James say this?

6.

Katie and Emma are playing in the house. Emma picks up a banana from the fruit bowl and holds it up to her ear. She says to Katie, “Look! This banana is a telephone!”

Q. Is it true what Emma says?

Q. Why does Emma say this?

7.

One day, while she is playing in the house, Anna accidentally knocks over her mother's favourite crystal vase. Oh dear, when mother finds out she will be very cross! So when Anna's mother comes home and sees the broken vase and asks Anna what happened, Anna says, "The dog knocked it over, it wasn't my fault!"

Q. Was it true, what Anna told her mother?

Q. Why did she say this?

8.

It is Halloween, and Chris is going to a fancy-dress party. He is going as a ghost. He wears a big white sheet with eyes cut out to see through. As he walks to the party in his ghost costume, he bumps into Mr Brown. It is dark, and Mr Brown says, “Oh! Who is it?” Chris answers, “I’m a ghost, Mr Brown!”

Q. Is it true, what Chris says?

Q. Why does Chris say this?

10.

During the war, the Red army captures a member of the Blue army. They want him to tell them where his army's tanks are; they know they are either by the sea or in the mountains. They know that the prisoner will not want to tell them, he will want to save his army, and so he will certainly lie to them. The prisoner is very brave and very clever, he will not let them find his tanks. The tanks are really in the mountains. Now when the other side ask him where his tanks are, he says, "They are in the mountains".

Q. Is it true what the prisoner said?

Q. Where will the other army look for his tanks?

Q. Why did the prisoner say that?

12.

Jill wanted to buy a kitten, so she went to see Mrs. Smith, who had lots of kittens she didn't want. Now Mrs. Smith loved the kittens, and she wouldn't do anything to harm them, though she couldn't keep them all herself. When Jill visited she wasn't sure she wanted one of Mrs. Smith's kittens, since they were all males and she had wanted a female. But Mrs. Smith said, "If no one buys the kittens I'll just have to drown them!"

Q. Was it true, what Mrs Smith said?

Q. Why did Mrs. Smith say that?

14.

Helen waited all year for Christmas, because she knew at Christmas she could ask her parents for a rabbit. Helen wanted a rabbit more than anything in the world. At last Christmas Day arrived, and Helen ran to unwrap the big box her parents had given her. She felt sure it would contain a little rabbit in a cage. But when she opened it, with all the family standing round, she found her present was just a boring old set of encyclopaedias, which Helen did not want at all! Still, when Helen's parents asked her how she liked her Christmas present, she said, "It's lovely, thank you. It's just what I wanted".

Q. Is it true, what Helen said?

Q. Why did she say this?

16.

A burglar who has just robbed a shop is making his getaway. As he is running home, a policeman on his beat sees him drop his glove. He doesn't know the man is a burglar, he just wants to tell him he dropped his glove. But when the policeman shouts out to the burglar, "Hey, you! Stop!", the burglar turns round, sees the policeman and gives himself up. He puts his hands up and admits that he did the break-in at the local shop.

Q. Was the policeman surprised by what the burglar did?

Q. Why did the burglar do this, when the policeman just wanted to give him back his glove?

19.

William is a very untidy boy. One day his mother comes into his bedroom, and it is even more messy than usual! There are clothes, toys, and comics, everywhere. William's mother says to William, "This room is a pig sty!"

Q. Is it true that William keeps pigs in his room?

Q. Why does William's mother say this?

22.

Yvonne is playing in the garden with her doll. She leaves her doll in the garden when her mother calls her in for lunch. While they are having lunch, it starts to rain. Yvonne's mother asks Yvonne, "Did you leave your doll in the garden?" Yvonne says, "No, I brought her in with me, mummy".

Q. Is it true, what Yvonne says?

Q. Why does Yvonne say this?

SST Instructions – Half 2

Table 1

Administration Order

Participant Number	Part 1 of Session 1	Part 2 of Session 1
1, 5, 9, 13, 17, 21;	Tally condition, SST half 1	Strategy condition, SST half 2
2, 6, 10, 14, 18, 22;	Tally condition, SST half 2	Strategy condition, SST half 1
3, 7, 11, 15, 19, 23;	Strategy condition, SST half 1	Tally condition, SST half 2
4, 8, 12, 16, 20, 24.	Strategy condition, SST half 2	Tally condition, SST half 1

**** Start recording ****

Strategy Condition: "Here are some stories and some questions."

"I'm going to read out the stories and I'd like you to listen carefully,
and help me with the questions at the end of each story."

"From time to time, you may hear a sound being played in the background. **** play audio sample **** Please think back to what you have learned today about theory of mind and understanding other people's thoughts, feelings, and intentions. When you hear the sound I just played, please try to put yourself in the position of each of the different characters and try to imagine what might be going through their minds before answering the questions. Do you have any questions?"

"When you hear the sound, please pay attention to the perspective of each character."

Tally Condition: "Here are some stories and some questions."

"I'm going to read out the stories and I'd like you to listen carefully,
and help me with the questions at the end of each story."

"From time to time, you may hear a sound being played in the background. **** play audio sample **** When you hear the sound I just played, please make a mark on this sheet to keep a record how many tones there have been. Do you have any questions?"

"When you hear the sound, please make a mark on the sheet in front of you."

**** Start audio cues ****

1.

At school today John was not present. He was away ill. All the rest of Ben's class were at school, though. When Ben got home after school his mother asked him, "Was everyone in your class at school today?" Ben answers, "Yes, Mummy".

Q. Is it true what Ben said?

Q. Why did Ben say that?

4.

Emma has a cough. All through lunch she coughs and coughs and coughs. Father says, “Poor Emma, you must have a frog in your throat!”

Q. Is it true, what Father says to Emma?

Q. Why does he say that?

9.

Simon is a big liar. Simon's brother Jim knows this, he knows that Simon never tells the truth! Now yesterday Simon stole Jim's ping-pong bat, and Jim knows Simon has hidden it somewhere, though he can't find it. He's very cross. So he finds Simon and he says, "Where is my ping-pong bat? You must have hidden it either in the cupboard or under your bed, because I've looked everywhere else. Where is it, in the cupboard or under your bed?" Simon tells him the bat is under his bed.

Q. Was it true, what Simon told Jim?

Q. Where will Jim look for his ping-pong bat?

Q. Why will Jim look in the cupboard for the bat?

11.

Brian is always hungry. Today at school it is his favourite meal - sausages and beans. He is a very greedy boy, and he would like to have more sausages than anybody else, even though his mother will have made him a lovely meal when he gets home! But everyone is allowed two sausages and no more. When it is Brian's turn to be served, he says, "Oh, please can I have four sausages, because I won't be having any dinner when I get home!"

Q. Is it true, what Brian says?

Q. Why does he say that?

13.

One day Aunt Jane came to visit Peter. Now Peter loves his aunt very much, but today she is wearing a new hat; a new hat which Peter thinks is very ugly indeed. Peter thinks his aunt looks silly in it, and much nicer in her old hat. But when Aunt Jane asks Peter, "How do you like my new hat?", Peter says, "Oh, its very nice".

Q. Was it true what Peter said?

Q. Why does he say that?

15.

Late one night, old Mrs. Peabody is walking home. She doesn't like walking home alone in the dark because she is always afraid that someone will attack her and rob her. She really is a very nervous person! Suddenly, out of the shadows comes a man. He wants to ask Mrs. Peabody what time it is, so he walks towards her. When Mrs. Peabody sees the man coming towards her, she starts to tremble and says, "Take my purse, just don't hurt me please!"

Q. Was the man surprised at what Mrs. Peabody said.

Q. Why did she say that, when he only wanted to ask her the time?

17.

Daniel and Ian see Mrs Thompson coming out of the hairdresser's one day. She looks a bit funny because the hairdresser has cut her hair much too short. Daniel says to Ian, "She must have been in a fight with a lawnmower!"

Q. Is it true, what Daniel says?

Q. Why does he say this?

18.

On Christmas Eve Alice's mother takes her to the big department store in town. They go to look in the toy department. In the toy department Mr. Brown, Alice's next-door neighbour, is dressed up as Santa Claus, giving out sweets to all the children. Alice thinks she recognises Mr. Brown, so she runs up to him and asks, "Who are you?" Mr. Brown answers, "I'm Santa Claus!"

Q. Is it true what Mr. Brown says?

Q. Why does he say this?

20.

Ann's mother has spent a long time cooking Ann's favourite meal; fish and chips. But when she brings it in to Ann, she is watching TV, and she doesn't even look up, or say thank you. Ann's mother is cross and says, "Well that's very nice, isn't it! That's what I call politeness!"

Q. Is it true, what Ann's mother says?

Q. Why does Ann's mother say this?

21.

Today, Katy wants to go on the swings in the playground. But to get to the playground she knows she has to pass old Mr. Jones' house. Mr. Jones has a nasty fierce dog, and every time Katy walks past the house the dog jumps up at the gate and barks. It scares Katy awfully, and she hates walking past the house because of the nasty dog. But Katy does so want to play on the swings. Katy's mother asks her, "Do you want to go out too the playground?" Katy says, "No".

Q. Is it true what Katy says?

Q. Why does she say she doesn't want to go to the playground, when she So wants to go on the swings that are there?

23.

Mark and Adam are having great fun! They have turned the kitchen table upside down and they are sitting in it, paddling along with rolled up newspapers. When their mother comes in she laughs. “Whatever are you two doing?, she asks. “This table is a pirate ship”, says Adam, “And you had better get in too before you sink – because you are standing in the sea!

Q. Is it true what Adam says?

Q. Why does he say this?

24.

John hates going to the dentist, because every time he does to the dentist he needs a filling, and that hurts a lot. But John knows that when he has toothache, his mother always takes him to the dentist. Now John has bad toothache at the moment, but when his mother notices he is looking ill and asks him, “Do you have tooth-ache, John?”, John says, “No, Mummy”.

Q. Is it true, what John says to his mother?

Q. Why does John say this?

Appendix 3 – Theory of Mind Training

[Redacted due to picture copyright]

Appendix 4 – ToM Training Instructions

23-11-18

Meta-Cognitive Training – Instructions Protocol
6. Module B (BADE Version)

General Instructions

- Room arrangement: A quiet room with a table and two chairs.
- Technical equipment: A laptop to show the PowerPoint presentation. Ideally, a power outlet for charging.
- Atmosphere:
    - The training should not be rushed.
    - Participants should be encouraged but not pushed to interact, with the trainer adopting a supportive and respectful manner.
    - From time to time, it may be necessary that the trainer highlights basic rules of interpersonal engagement (e.g., eye contact, active listening, show respect for different opinions).
    - A friendly atmosphere – the exercises should be interactive and playful.
    - It may at times be helpful to enquire about the participant's confidence.

Slide	Verbal Instructions	Time (in s)
1	"Social situations are really complicated. After brain injury, they can feel even more complicated, for example as attention and concentration problems might make it difficult to keep up with conversations or keep track of different perspectives. As another example, some injuries impact on our ability to recognise and understand social information, such as facial expressions. This training aims to 'break down' social situations into different components and introduce strategies that we can use to understand social situations better." "This training has been developed to look at how we think and act in social situations. We will be discussing how to interpret clues people give us to understand what they might be thinking or feeling. We will also be looking at some common scenarios to appreciate other people's perspectives." "Please follow closely as we go through the presentation. You may interrupt me to ask questions, or to say if I'm going too fast or slow, and I'll ask you what you think too, so try to follow closely and let me know if you would like anything repeated. The whole training will take about 20-25 minutes."	60

Slide	Verbal Instructions	Time (in s)
2	"Please have a look at this picture. When you get to know someone, where do you look first?" [**await participant response**] "How reliable are these cues for a good evaluation?"	30
3	"That's right. / That's not quite right. [**depending on participant response(s)**] You may also look at someone's eyes… what they say (language)… clothes… hands… body language or posture [**instructor points at respective arrows**]. Can you think of any others?" [**await participant response**]	30
4	"What other sources of information may be considered?" [**await participant response**]	15
5	"How reliable are these cues for a good evaluation?" [**await participant response**]	15
6	"- Prior knowledge on person (hearsay): for example, a remark by a friend - Prior knowledge on similar persons/groups: e.g. biker - "Gut feeling"/intuition - Something written: for example, from e-mails or internet chats Not all of these will be equally reliable in all situations."	30
7	"Now that we have discussed aspects contributing to the appraisal of a person, We shall focus on the strengths and weaknesses of these social cues." [**optional: ask participant to summarize**]	45
8	"What are some of the advantages and disadvantages of body language for making a judgement about a person?" [**demonstrate gesture**]	30
9	"Are they praying or being cold? What can give you an important clue?" [**await participant response**]	30
10	[**point at "Important clue"**] "Gesture and posture can emphasise words (e.g., clenched fists when angry, raised hand when greeting, lowered head when praying). Indirect signs are often meaningful: wild gestures *can* indicate nervousness (however, it's important to be aware of cultural differences!); slouching can be a sign of low self-confidence."	30

Slide	Verbal Instructions	Time (in s)
11	[**point at "Caution"**] "However, body language can lead to false interpretation. For example: Someone who looks self-confident can be putting up a front. Or postural stoop can appear as if someone has low self-confidence."	30
12	"What are some of the advantages and disadvantages of written language for making a judgement about a person?" [**point to picture**]	30
13	"Are they expressing sarcasm, sympathy or using an empty phrase?" [**await participant response**]	30
14	[**point at "Important clue"**] "We often think more about what we write than about what we say!"	15
15	[**point at "Caution"**] "Sometimes, you have to read between the lines to understand the meaning. However, this can lead to incorrect conclusions! A new study shows that email-writers and email-readers are very confident about the "tone" of an email. In reality, there is a congruency of about 56%, which is little above chance!"	30
16	"What are some of the advantages and disadvantages of the following feature for making a judgement about a person?" [**point to Previous knowledge about similar people / culture**] Do people have ideas about what a 'typical Muslim' or 'typical German' might look or be like?" [**await participant response**]	60
17	[**point at "Important clue"**] "Knowing a different culture or ethnic group helps to understand people who belong to that group. Every culture has its own unwritten social laws."	15
18	[**point at "Caution"**] "People often act in a non-stereotypical way! People who share a certain faith or people from certain countries are sometimes confronted with prejudices (e.g., Muslims are fanatic; US-Americans are arrogant and only eat junk-food)."	30
19	"In summary, body language, written statements, and cultural knowledge can all help in interpreting social situations."	10
20	"HOWEVER, taking each on their own, there is the possibility that they could be misinterpreted."	10
21	"It is important to gather *as much* information as possible before coming to firm conclusions."	10

Slide	Verbal Instructions	Time (in s)
22	"In other words… Appearance and reality! None of the previously discussed aspects (e.g., body language) can be completely trusted on their own! One has to consider all aspects! In combination, they help with judging a complex situation…"	30
23	"Why are we doing this? Studies show that many [but not all!] people with *acquired brain injury* have problems in the following areas:"	10
24	"- Difficulties detecting and evaluating the facial expressions of others (e.g., joy, grief)."	10
25	"- Difficulties deducing the motives / future activities of other persons from on-going behaviour."	10
26	Read example: "After the doctor talked to you, …"	10
27	Read example: "A pedestrian looks at you twice…"	10
28	Read example: "Another person blinks at you. […]"	10
29	"Thinking too quickly can lead to errors – some examples" [Table header: "explanation during psychosis" → "*possible explanation following brain injury*"] "Can *you* contribute a short personal experience?" [**await participant response**] "This is a good example." / "This is not quite the example we had in mind. A different example might be when you see a friend in the street – you greet them, but they don't greet you back. You may think at first that they might ignore you. A different explanation is that they simply may not have seen you or have been lost in thought." [**depending on participant response(s)**]	75
30	"Exercise In the following, you will be presented with comic strips. What may the characters in the story think about each other?"	30
31	"Important You have to distinguish between information available to you and information the characters have about one another! Consider, what additional information is needed to provide a definite answer?"	30

Slide	Verbal Instructions	Time (in s)
32	"Example: An overweight man falls off a chair" [**Show participant the order of comic pictures; allow him/her to look at and consider them**] "What might people think? Are they correct?" [**await participant response**] "That makes sense." / "That's not quite right. Let's have a look at some options." [**depending on participant response(s)**]	60
33	"- Likely: Man is too heavy for chair. - Less likely: Man has tilted on his chair; chair is too fragile. - Very unlikely assumption that people may have had but is true: Chair has been cut with a saw - unlikely assumption because no one observed the boy in the first picture sawing the leg of the chair"	30
34	[**Show participant the order of comic pictures; allow him/her to look at and consider them**] "What might the man think?" [**await participant response**] "That is a reasonable interpretation." / "That is not quite right." [**depending on participant response(s)**] "Let's have a look at some additional information."	30
35	"Have a look at the very first picture. Does this change your interpretation? Why?" [**await participant response**] "Good." / "Can you explain why this does not change your interpretation?" [**depending on participant response(s)**]	30
36	"Keep off the grass" [**point to the respective picture**] "What does the park ranger probably think? Is he correct?" [**await participant response**] "That is a reasonable interpretation." / "That is not quite right." [**depending on participant response(s)**] "Let's have a look at some additional information."	30
37	"Have a look at the additional pictures. Does this change your interpretation? Why?" [**await participant response**] "Good." / "Can you explain why this does not change your interpretation?" [**depending on participant response(s)**]	45

Slide	Verbal Instructions	Time (in s)
38	"What might the man in front of the picture think?" [**point to the respective picture**] "Is he correct?" [**await participant response**] "That is a reasonable interpretation." / "That is not quite right." [**depending on participant response(s)**] "Let's have a look at some additional information."	30
39	"Have a look at the additional pictures. Does this change your interpretation? Why?" [**await participant response**] "Good." / "Can you explain why this does not change your interpretation?" [**depending on participant response(s)**]	45
40	"What is the mother thinking?" [**point to the respective picture**] "Do we need additional information to decide?" [**await participant response**] "That is a reasonable interpretation." / "That is not quite right." [**depending on participant response(s)**] "Let's have a look at some additional information."	30
41	"Have a look at the additional pictures. Does this change your interpretation? Why?" [**await participant response**] "Good." / "Can you explain why this does not change your interpretation?" [**depending on participant response(s)**]	45
42	"What might the man walking the dog think?" [**point to the respective picture & await participant response**] "That is a reasonable interpretation." / "That is not quite right." [**depending on participant response(s)**] "Let's have a look at some additional information."	30
43	"Have a look at the additional pictures. Does this change your interpretation? Why?" [**await participant response**] "Good." / "Can you explain why this does not change your interpretation?" [**depending on participant response(s)**]	30
44	"What might the man in the final picture think?" [**point to the respective picture**] "Is he correct?" [**await participant response**] "That is a reasonable interpretation." / "That is not quite right." [**depending on participant response(s)**] "Let's have a look at some additional information."	30

Slide	Verbal Instructions	Time (in s)
45	"Have a look at the additional pictures. Does this change your interpretation? Why?" [**await participant response**] "Good." / "Can you explain why this does not change your interpretation?" [**depending on participant response(s)**]	30
46	[**Summary & transfer to everyday life (Part I): Read slide Ask participant to summarize slide content in their own words**]	30
47	[**Summary & transfer to everyday life (Part II): Ask participant to read slide / read slide as instructor Ask participant to summarize slide content in their own words**]	30
48	[**n/a**]	0
49	[**n/a**]	0
50	"What does this have to do with *me*? *After brain injury,* many [but not all!] people are in danger of misinterpreting or over-interpreting facial expressions and actions. Example: Neil feels stared at, he has the feeling that: "They are out to get me." Background: Neil has been fearful/frightened for weeks and is wearing dark sunglasses for disguise. But!: Because of his peculiar behaviour, he is attracting special attention. Others are looking at him to try to figure out why he is acting the way he is. We all make mistakes! Always take different perspectives into account."	45
51	"Thank you for your attention! Do you have any questions?" [**Respond to potential participant queries**]	30
	TOTAL	24 minutes

Systematic Literature Review

A Systematic Review of Behavioural Assessment Tools for Social Cognition in People with Traumatic Brain Injury

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Word count: 17,912

TABLE OF CONTENTS

Abstract

Social cognition refers to people's mental abilities to perceive, process, and interpret interpersonal information. Traumatic brain injury can result in various adverse effects due to the diffuse localisation of social cognition capacities across the two cerebral hemispheres. The aim of this systematic review was to identify and evaluate current behavioural measures for social cognition in adults with traumatic brain injury. Eighty-one studies were identified and assessed on the quality of reporting about their methodology and interpretation of findings. Seventy-eight unique measures were evaluated in terms of their reported statistical reliability and validity. Validity was reported for 19 measures (24.4%) and reliability for 28 measures (35.9%), while both were available for twelve tools (15.4%). The current review highlighted the availability of social cognition measures for the assessment of social perception (particularly facial and verbal emotion), theory of mind, and social behaviour (e.g. communication skills, emotional decision-making, and social skills). Gaps in the literature were identified with regards to the assessment of affective empathy, humour/sarcasm, and personality. Recommendations are given for important elements of clinical practice to consider, such as specific recommended assessment tools, aspects of social cognitive formulation, and confounding factors, such as co-occurring conditions where social cognition impairments are common.

Social Cognition

Social cognition is an umbrella term for the mental facilities required to perceive, process, and interpret social information (McDonald, 2017). A large body of literature on social cognition now exists, including reviews that have offered models (Cassel et al., 2016; Yeates et al., 2007) and conceptualisations concerning social cognition (Adolphs, 2010; Milders, 2019; Njomboro, 2017; Roelofs et al., 2017). The working model of social cognition for this review comprises theory of mind, affective empathy, social perception, and social behaviour, based on the work by Henry, Hippel, Molenberghs, Lee, and Sachdev (2016).

Previous work in this area will be examined first (Adolphs, 2010; Cassel et al., 2016; Milders, 2019; Njomboro, 2017; Roelofs et al., 2017; Yeates et al., 2007) before laying out the rationale for the above choice of model. Review articles have been selected for their relevance to the subject at hand and in the case of Yeates (2007) and Adolphs (2010), for their high citation counts. Cassel and colleagues (2016) have divided social cognition into perception and attention, interpretational biases, emotion perception, self-awareness, theory of mind, affective empathy as well as social behaviour. Each aspect is hypothesised to feed into social situations. These in turn are influenced by biological and neuropsychological factors (cognition, motor skills, and language) as well as psychological and environmental factors (socio-cultural context, past experience, and mood). Yeates' (2007) produced a model that built on work in child psychology and focusses on the concept of social competence. This concept is defined as a person's ability to navigate interpersonal encounters as an individual, in dyads, and in groups (Bukowski et al., 2001) and therefore closely relates to social cognition. Yeates' model (2007) incorporated social information processing (separated into cognitive-executive functions, social problem-solving, and social-affective functions), social interaction (affiliative, aggressive, withdrawn), and social adjustment (self-perceptions, perceptions of others). Adolphs' conceptualisation (2010; also referred to in McDonald et al., 2013) was aimed particularly at the role of the amygdala in social cognition and is limited to facial information processing, coding salience or relevance, and reward learning. Additional models include that by Njomboro (2017) who emphasised the domains of emotion recognition, theory of mind, and empathy as well as social judgements and social awareness in his definition. Milders (2019) also included the perception of social cues, empathy, and theory of mind ('understanding other people's intentions') in his review of social cognition and social behaviour after traumatic brain injury. Finally, Roelofs and colleagues (2017) conceptualised social cognition as incorporating emotion perception, social perception, theory of mind, social functioning, as well as the inability to describe and identify emotions in others and in oneself (alexithymia).

Examining the scope of the above models and conceptualisations, what they have in common is that they refer to aspects of social cognition in the domains of social perception and attention (e.g. facial affect perception), 'hot' emotion processing (e.g. empathy), 'cold' cognition around socially relevant information (e.g. theory of mind), and social behaviour (e.g. situational judgement). Conceptualisations by Adolphs (2010) and Milders (2019) thus appear somewhat limited. Yeates (2007) as well as Cassel and colleagues (2016) have offered extended models which incorporate internal (e.g. physical and cognitive resources) and external (e.g. cultural context) factors which may modify social cognitive abilities. The model by Henry and colleagues (2016) is considered to be suitably comprehensive and specific for the purposes of this review. It combines the essential elements of the models and conceptualisations analysed above without straying into distantly related concepts (e.g. generic cognition, cultural/societal factors).

The four elements of the working model of social cognition – theory of mind, affective empathy, social perception, and social behaviour – warrant being defined in their own right (Henry, Hippel, et al., 2016). Firstly, theory of mind refers to the ability to understand other people's intentions, thoughts, beliefs or other states of mind as well as the recognition that these can be different from one's own (Baron-Cohen, 1991; Fazaeli et al., 2018). Preckel, Kanske, and Singer (2018) have argued that theory of mind incorporates an affective component, meaning the capacity to comprehend other people's feelings, moods and emotions, though this is closely related to affective empathy. Affective empathy, which is the second component of the current review, relates to other-oriented emotional responses (Bonfils et al., 2016; D. Watt, 2007). Affective empathy can be congruous (e.g. feeling someone else's pain) or incongruous (e.g. feeling embarrassed at somebody else's misfortune), but congruity does not necessarily determine the appropriateness of the affective response. Instead, this will invariably depend on situational factors (e.g. sobbing uncontrollably when a friend stubs their toe). Watt (2007) has argued that affective empathy is a separate entity from more cognitive components of empathy (theory of mind, perspective-taking, and emotion identification) as well as from more affective processes (attachment and contagion), suggesting that it may therefore require distinct assessment measures. Thirdly, social perception describes the ability to observe and react to others' emotional or social cues, such as eye gaze, changes in voice pitch, body language or facial expression (Adolphs et al., 2016; Yang et al., 2015). Finally, social behaviour includes a widely, though often unspoken, set of rules about how to compose oneself in interpersonal scenarios, or social tact. It becomes conspicuous when people behave in social situations in ways that are unexpected. Examples include unsolicited and/or overly friendly contact with strangers, reduction in communicative gestures, overstepping of interpersonal boundaries or generally poor social tact (Baron-Cohen et al., 1999; Lee et al., 2010; Milders, 2019). The

other aspects of Henry and colleagues' (2016) model may feed into social behaviour. In this sense, maladaptive social behaviour may arise from failures in social perception (e.g. misinterpretations of social cues), knowledge (e.g. lack of understanding of social rules), empathy (e.g. misattribution of interpersonal feelings) or a combination of these.

Reviews of more specific aspects of social cognition that may be affected by traumatic brain injury have focussed on social decision-making (Clark & Manes, 2004), social behaviour (Douglas, 2017; Sloan et al., 2004), and emotional deficits, for example empathy (Wood, 2013).

Various psychiatric and neurological conditions are known to affect social cognitive faculties, such as neurotransmitter abnormalities (Adolphs, 2001), stroke (Yuvaraj et al., 2013) and epilepsy (Bora & Meletti, 2016; Hamiwka et al., 2011), neurodevelopmental disorders, such as autism spectrum disorder (Fernández et al., 2018), or severe mental illness, such as psychosis/schizophrenia (M. F. Green et al., 2015; Kennedy & Adolphs, 2012). Yuvaraj and colleagues (2013) found that deficits in perceiving emotions in written presentation, facial displays or prosody was more common in right- than left-hemisphere stroke. Bora and Meletti (2016) showed that temporal lobe epilepsy is associated with impairments in theory of mind and the perception of emotion from faces, particularly fear, sadness, and disgust, in individuals with an epileptic focus in the right temporal lobe. Social cognition deficits in autism spectrum disorders include processing of emotional facial expressions, identification of emotions from prosody, and mental state attributions (Pelphrey et al., 2004). In individuals diagnosed with schizophrenia, social cognition impairments may present as difficulties with interpersonal thought inferences, feelings of connectedness, emotion identification, and reacting in an emotionally exaggerated way to others (M. F. Green et al., 2015). Moreover, social cognitive interventions and social inclusion have been shown to promote neuroplasticity in animal models and healthy humans (Davidson & McEwen, 2012). While social cognitive difficulties occur in a range of different conditions, the present review will focus on traumatic brain injury.

Neuroanatomy of Social Cognition

Many brain areas are involved in social cognitive function, including areas of frontal and temporal cortices as well as subcortical regions. Early research in affective neuroscience focussed on the hypothesis that emotional perception and processing is linked to specific brain areas (localizationist approach; Adolphs, 1999). Most notable are areas such as the dorsomedial, ventromedial, and orbitofrontal prefrontal cortices, the temporal poles, superior temporal sulcus, temporoparietal junction, and intraparietal sulcus as well as the anterior cingulate gyrus, amygdala and hippocampus, as reviewed by Dickerson (2015).

There is support for this work for example from lesions studies. Well-known cases include Phineas Gage (1823-1860; Damasio, Grabowski, Frank, Galaburda, & Damasio, 1994) and E. V. R. (Eslinger & Damasio, 1985) whose localised orbitofrontal lesions have been linked to lasting changes in decision-making and emotion processing. Work with people with acquired ventromedial prefrontal lesion showed that they could demonstrate intact intellectual performance and startle response (e.g. to a loud noise), but struggle establishing the trustworthiness of new compatriots (A .R. Damasio et al., 1990). Further, Amygdala lesions have been linked to difficulties with the processing of facial emotions, direction of eye gaze, and reduced emotional expression (Aggleton, 1992; Young et al., 1995). In another example, Cicerone and Tanenbaum (1997) described a case of social-cognitive difficulties following traumatic injury to the orbitofrontal cortex.

However, the approach concentrating on discrete brain areas has been broadened to a perspective which posits that emotions and affective appraisals are produced by multi-purpose brain networks (Lindquist et al., 2012). This is because social cognitive functions are distributed across the brain. Traumatic brain injury rarely affects single areas which is a preferred method of study under the localizationist approach and it is debated whether brain areas can support social cognitive functions independent of one another (modularity; McDonald, 2013). Diffuse damage caused by traumatic brain injury can affect social behaviour, social perception, theory of mind, and affective empathy through impact on local and/or global networks (Barbey et al., 2015; Van Der Horn et al., 2016). For instance, empathetic abilities may be supported by areas such as the anterior cingulate and insula which, due to their location within the cerebrum, might be less susceptible to direct injury, yet still susceptible by white matter deformations (Lockwood, 2016).

Introduction to Traumatic Brain Injury

Traumatic brain injury (TBI) has been defined as “an alteration in brain function, or other evidence of brain pathology, caused by an external force” (Menon et al., 2010). Here, altered brain function refers to a loss of consciousness, post-traumatic amnesia, neurological deficits (e.g. sensory loss), and changes in mental state around the time of the injury (e.g. confusion or disorientation). TBI is frequently caused by motor vehicle accidents in young people and by falls in older people (Ghajar, 2000; Shivaji et al., 2014). In the UK, TBI is the primary reason for about 10% of A&E visits with 2% requiring hospitalisation (Alexander, 2003). Rates across countries may vary due to population size and cultural differences (Larsen et al., 2016; Simpson et al., 2000). Nevertheless, TBI is one of the main causes of disability and death in the Western world and is therefore associated with significant financial

and psychological burden (Bruns & Hauser, 2003; Corrigan et al., 2010; Moppett, 2007; Werner & Engelhard, 2007).

Evidence from hospital records (Cepeda et al., 2015) and computer simulations (El Sayed et al., 2008) indicates that TBI commonly affects frontal and temporal lobes in the primary injury phase. These areas tend to be more susceptible to focal brain damage due to contusion, laceration, and intracranial haemorrhage upon the primary impact as the brain moves within the closed cranial space (Alexander, 2003; Werner & Engelhard, 2007). Additional damage to axonal connections can occur following acceleration-deceleration forces during the injury, also referred to as shearing (Gennarelli et al., 1998; Ma et al., 2016). Diffuse axonal injury may affect local or long-distance networks, with lesions to the corpus callosum being associated with worse outcomes, such as more severe disability (van Eijck et al., 2018). Secondary damage to the brain may be caused after the initial injury due to physiological mechanisms, such as reduced cerebral oxygenation or hydrocephalus (Kammersgaard et al., 2013; Werner & Engelhard, 2007).

People with TBI may experience difficulties in their physical health (e.g. mobility), employment prospects (e.g. due to adjustments required), and cognition (e.g. attention, memory; Carney et al., 1999). They can develop greater independence through multi-disciplinary rehabilitation, for instance with teaching of compensatory strategies, gradual build-up in goals to cope with daily challenges, and behaviour management (Alexander, 2003; Giles, 2017). Outside of cognitive and physical ramifications, however, findings by Finset, Dyrnes, Krogstad, and Berstad (1995) indicate the impact of TBI can manifest through a change in the receipt of social support and interpersonal networks. While people with TBI may find that they receive additional help and input from significant others, 57% of participants in one study stated that their overall social networks had shrunk (Finset et al., 1995). In a related vein, individuals with TBI reported greater loneliness, but not significantly smaller social networks compared to healthy controls in a second study (Rigon et al., 2019). Conversely, survivors of TBI may experience stigma and discrimination from the public due to a lack of knowledge about the cognitive, emotional, and social consequences of brain injuries. This is more pronounced if individuals belief that the person with TBI holds a level of responsibility for their accident (Ralph & Derbyshire, 2013).

Social Cognition in Traumatic Brain Injury

Difficulties with social cognition following TBI often present as problems in establishing or maintaining personal relationships, withdrawal or inappropriate social behaviour, such as poor decorum (Driscoll et al., 2010). McDonald (2013) highlights that much of the difficulty, both for people with TBI and for researchers attempting to investigate

their social deficits, lies in the fact that social information is often not directly observable or objectively quantifiable and needs to be inferred from people, the environment, and non-verbal context.

As stated, TBI is likely to involve prefrontal and temporal brain areas which are crucial in the processing of social information (Driscoll et al., 2010). However, symptoms of poor social cognition in one person with TBI compared to another can be highly variable, complicated by factors such as white matter injury (McDonald, Dalton, Rushby, & Landin-Romero, 2018; McDonald, Rushby, Dalton, Allen, & Parks, 2018). These may limit, for example, the integration of verbal (e.g. what a person says) and non-verbal social information (e.g. intonation, gesture, facial expression or eye gaze giving additional meaning to their speech). Similarly, it is important to be mindful of pre-existing individual differences (Ibáñez et al., 2014; Von Hippel et al., 2005; Wilhelm et al., 2010) or those of a concomitant mood disorder in which social isolation and altered emotion regulation are common (Dryman & Heimberg, 2018; McDonald, 2013). These may account for or exacerbate social cognitive difficulties.

The assessment and treatment of as well as research on social cognition in TBI is still in its beginnings and builds on more established work in conditions such as autism spectrum disorders and schizophrenia (G. Martinez et al., 2017; Pilling et al., 2002). This is an area of great need given that social cognition deficits are associated with poorer psychosocial functioning in TBI, such as inappropriate behaviour, social withdrawal or difficulties in establishing or maintaining functional relationships (Driscoll et al., 2010; Levine, Van Horn, & Curtis, 1993; McDonald et al., 2012). Social cognition impairments tend to be related to poorer employment outcomes (Douglas et al., 2016), rates of which tend to be reduced compared to those without TBI even years after the original injury (Grauwmeijer et al., 2017; Ownsworth & McKenna, 2004).

Cassel and colleagues (2016) have pointed out that it is difficult to define the incidence of social cognition deficits following TBI. Whilst the occurrence of facial emotion processing impairments has been estimated at between 13-39% in people with moderate to severe TBI (Babbage et al., 2011), this does not encompass other forms of social information processing, such as emotionally relevant vocal cues (Cassel et al., 2016). Furthermore, 30-60% of people with moderate to severe TBI may struggle to label their own emotional states accurately (i.e., alexithymia), limiting their ability to apply such concepts in the social arena (Cassel et al., 2016; McDonald et al., 2011; Neumann et al., 2014). Theory of mind deficits appear to be a common occurrence following traumatic brain injury, as well as other forms of acquired brain injury (Martín-Rodríguez & León-Carrión, 2010). Impairments of theory of mind have been linked to aggression (Fazaeli et al., 2018) across the spectrum of TBI severity (Kim, 2002), for example due to misattribution of negative

attitudes to others in ambiguous social scenarios (Aguiar, 2013). Assessment tools for theory of mind have often been originally developed for research into autism spectrum disorders (Baron-Cohen et al., 1999; Happé, 1994). Some tasks involve identifying theory of mind-specific skills by contrasting participants' understanding of stories focussed on mental states compared to physical states (e.g. Happé, Brownell, & Winner, 1999). A challenge in the assessment of theory of mind includes the potentially conflicting demands required in processing language, memory load, and social reasoning concurrently (Fazaeli et al., 2018).

Assessment of Social Cognition

Cross-national internet surveys on the assessment of social cognition after TBI by allied health professionals working in neurorehabilitation settings have been published by Kelly, McDonald, and Frith (2017a, 2017b). The first (Kelly, McDonald, & Frith, 2017a) enquired about clinicians' assessment practices around social cognition difficulties after TBI. Clinicians reported that clients' and their families' complaints of social cognition difficulties were common (half or more of clients in 84% of clinicians), though rarely assessed in a standardised way (78%). Most respondents quoted a lack of appropriate assessment tools as their primary obstacle (33% of clinicians). The second review, focussing on clinicians practising in Australia, established which tools they used for social cognition assessment and treatment in clients after TBI (Kelly, McDonald, & Frith, 2017b). A wide variety of tools were identified in the domains of alexithymia, theory of mind, social adjustment, anger, disinhibition, and insight. However, many clinicians expressed a preference for using informal methods for establishing rehabilitation goals. The two articles left a gap in the literature with regards to a *systematic* review of available social cognitive assessment tools and their psychometrics, which the present research aims to fill.

The comprehensive assessment of impairments following traumatic brain injury has been a long-standing challenge due to the lack of reliable, validated, and widely agreed assessment standards. The International Classification of Functioning, Disability and Health (ICF) was introduced by the WHO (2001) and may serve as a guide in this endeavour. Tate and colleagues (2013) have reviewed assessment tools available alongside the components of the ICF framework. Global assessments for mental functions encompass: consciousness, orientation, intellectual functioning, global psychosocial functioning, temperament and personality, energy and drive, as well as sleep. Under specific areas for testing, Tate and colleagues (2013) list: attention, memory, psychomotor ability, emotional functioning, perceptual abilities, thought, higher-level cognitive functioning, language, calculation, sequencing complex movements, and experience of self and time. Further tools are categorised under multi-category measures for mental functions, tests addressing body

functions, activities and participation as well as contextual factors, such as environmental and personal factors, and quality of life. Social cognition measures probably fall within a variety of these categories, specifically higher-level or multi-category cognitive functions as a result of neuropsychological impairment or change in psychological status, symptoms of TBI, and social roles, relationships, and interactions (Tate et al., 2013). For instance, Spikman and colleagues (2012) have argued that measures of social cognition are multi-factorial and tap into different cognitive functions, such as memory, perception or attention, simultaneously. This might be one of the reasons why social cognition assessments are typically considered to be more representative of everyday function outcomes than some other areas of neuropsychological testing, because they require adaptability and integration of cognitive abilities (Casaletto & Heaton, 2017).

The neuropsychological assessment of social cognition requires a suitable level of qualification and experience to arrive at appropriate diagnoses, formulations, and treatment planning (McDonald, 2013; Tarrier & Calam, 2002). This is important, because the outcome scores of neuropsychological assessments has been found to vary strongly depending on a range of demographic factors, particularly the age and level of education of the person being assessed (Bruns & Hauser, 2003; Finlayson et al., 1977; Fletcher, 2014; Tombaugh, 2004). Neuropsychological assessment of social cognition is sometimes grouped under executive testing or frontal lobe evaluation (e.g. error monitoring, planning, decision-making). It has been argued that decision-making is not a purely rational process, for instance in Damasio's (1996) somatic marker hypothesis. This hypothesis stipulates that perceived bodily processes (e.g. an increase in heart rate) influence emotional processing (e.g. perception of being excited) and in turn decision-making. Instead, research has demonstrated that decision-making is influenced by positive (e.g. reward; Diekhof, Falkai, & Gruber, 2008) and negative emotions (e.g. regret; Coricelli, Dolan, & Sirigu, 2007) as well as social context (Asch, 1951; D'Ascenzo et al., 2016). Primarily emotional decision-making has been argued to be maintained by a circuit comprising the ventromedial prefrontal cortex (vmPFC), ventral striatum, and amygdala (Bechara, 2004; Hiser & Koenigs, 2018; Ho et al., 2012), though a wider network has been proposed (Mitchell, 2011). However, a person can sustain injuries to one or multiple regions which are typically related to social-cognitive functioning (as listed above), but the impact on their executive functioning can vary widely, from remaining completely intact to being profoundly impaired (MacPherson & Della Salla, 2015). In sum, there are gaps in the current neuropsychological assessment of social cognition by professionals which require greater integration of available tools and consideration of both cognitive and affective components.

Scope of the Present Review

This review will focus on the behavioural assessment of social cognition in people with traumatic brain injury. Therefore, it excludes other forms of brain injury or illness, social cognition interventions, and neuroimaging studies on the subject.

It is apparent that wider meta-cognitive or social skills are often grouped under social cognition, such as executive function, motor skills, language/communication skills, socio-cultural context, past experiences or mood (Cassel et al., 2016). Related topics are social participation (Brasure et al., 2013), self-awareness (Klein et al., 2002), and social skills (Hynes et al., 2011) or return to work (Donker-Cools et al., 2016). Social participation includes interpersonal activities, such as productive employment or military service, or community integration (Brasure et al., 2013). Self-awareness is related to considerations about oneself and contains aspects such as thoughts, feelings, preferences, and action plans (Klein et al., 2002; Prigatano, 2005). Social skills are interpersonal abilities which are considered to be trainable, such as communication skills, self-confidence, boundary setting, and assertiveness (Braden et al., 2010). As such, these constructs focus on aspects other than an internal cognitive representation of external social phenomena, meaning they do fall outside the working definition adopted for this review.

Three types of assessment can be distinguished: self-report, other-report, and behavioural. This division is of value for clinical and research applications, as it allows the collection of information from a variety of sources and to triangulate results for comparison (Horton et al., 2018; Ponsford et al., 1999). Self-report assessments include measures, surveys, and questionnaires in which the participant evaluates their own performance in situations that place demands on social cognition. Other-report measures demand a similar kind of evaluation, but from a treating clinician of the participant or a significant other, such as a family member.

This review focusses specifically on behavioural measures, which are based on the measurement of performance or observation of activity, as social cognition is often embedded in behavioural interactions (Cassel et al., 2016). Behavioural measures typically require the participant's verbal or motor response following the consideration of a social stimulus, such as a picture, story or short video that relates to some form of social situation. Behavioural tasks are rule-based, open-ended, observable, and attempt to replicate a real world phenomenon (K. Robertson & Schmitter-Edgecombe, 2017). Such tasks can claim acceptable ecological validity, though this comes potentially at the risk of more complicated administration and increased cost. It would appear, at least for computerised tasks, that behavioural measures also have comparable reliability to traditional 'paper and pencil' assessments (Kontos et al., 2016). Lastly, it has been found that measures which are

oriented towards real world experiences can enhance participants' experiences of cognitive testing, though it appears that a direct effect on outcomes has not been established (Bennett-Levy et al., 1994).

Aims of the Review

The aims of the present systematic review are twofold:

- Present an overview of neuropsychological tools available for the behavioural assessment of social cognition and its potential impairments in people with traumatic brain injury, and
- Evaluate such assessment tools with regards to the validity and reliability cited in the respective research articles.

Methods

Search Strategy

Searches were carried out across two databases, Scopus and Web of Science. Each search included three elements: search terms under "keywords" for social cognition, assessment measures, and for different types of brain injury, including traumatic brain injury.

Social cognition search terms were chosen based on the extant literature in the area (see Introduction). Search terms for assessment measures were selected in an inclusive manner to encompass terms which may refer to behavioural measures and related types of assessments. Search terms for brain injury were picked in a comprehensive manner to find studies incorporating participants with traumatic brain injury as well as those where participants with traumatic brain injury may form one of the experimental groups. All search terms were passed through the OvidSP subject headings feature in order to identify relevant synonyms or alternative spellings and wordings. The full list of search terms is given in Appendix 5.

Study Selection

Studies were *included* if they [a] recruited adult participants (aged 18+ years) with a traumatic brain injury with or without explicit difficulties in social cognition (meaning social perception, theory of mind, affective empathy or social behaviour), [b] utilised a behavioural assessment tool targeting social cognition or social inference [c] which has been used in a

group of participants with traumatic brain injury or designed for this purpose. [d] Permissible study designs were cohort studies, scientific experiments, randomised controlled trials, and standardisation studies. [e] No limits were set in terms of study settings or comparator groups.

Studies were *excluded* if they were [a] conducted with children or adults who had acquired their brain injury in childhood, adults with brain injuries other than of the traumatic aetiology or in people with social cognition difficulties associated with another primary diagnosis (e.g. physical illness, mental illness or learning disability), [b] treatment or rehabilitation trials without a formal assessment of social cognition, [c] using self-report, other-report or otherwise non-behavioural types of social cognition assessments (e.g. neuroimaging tasks that require observation of, but not response to, social cognitive stimuli), [d] qualitative works, case series, experiments with fewer than 10 participants, reviews or commentaries or [e] reported in languages other than English. Commercial assessment batteries, like the Awareness of Social Inference Test (McDonald et al., 2002), were excluded due to their established availability, reliability, and validity.

Full titles and abstracts were imported into EndNote software (Clarivate Analytics, 2009) for review and selection. The program also removed duplicates. The study selection procedure is summarised in figure 1.

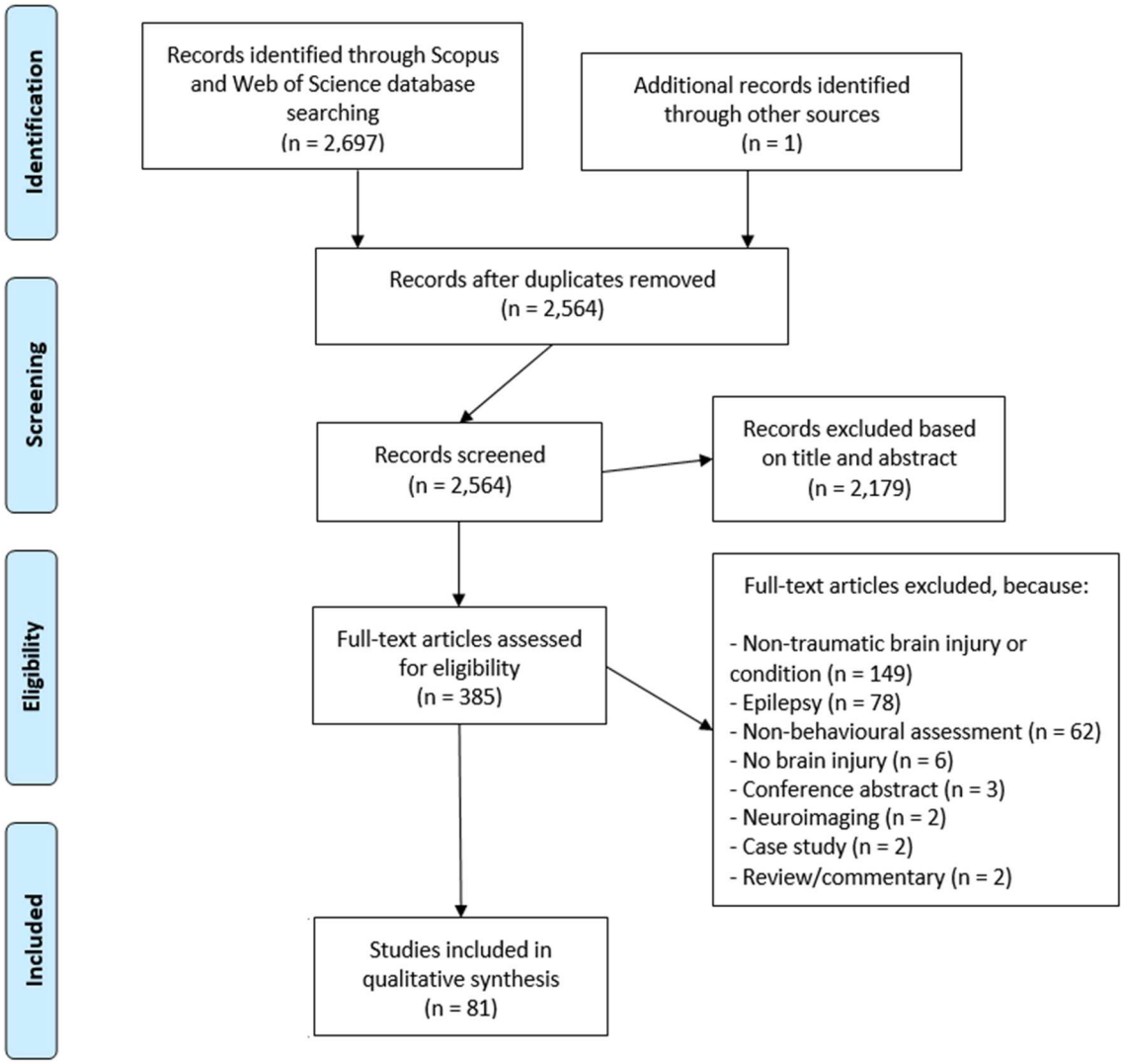

Figure 1. PRISMA flow diagram.

Validity and Reliability

Information on reliability and/or validity was extracted and evaluated from the included studies, depending on availability. Reliability and validity were selected as core quality markers of assessment tools, indicating whether they obtain comparable results in similar contexts across time as well as whether they measure the construct they are intended to assess, respectively (Field, 2017). Extracted data was divided into the type of validity/reliability, a short description (with statistical values where reported), and the source of the description/value (meaning either an analysis reported by the article authors or via quotation of an external reference). When no information regarding validity/reliability was reported, this was labelled as “not stated.”

Quality Assessment

The quality of the included studies was evaluated using the Standard Quality Assessment Criteria for Evaluating Primary Research Papers from a Variety of Fields (Kmet et al., 2004). It is a measure suitable for use with studies that use varied methodologies and has good inter-rater reliability. Each item is scored as 'yes' (score = 2), 'partial' (score = 1), or 'no' (score = 0), while items rated 'not applicable' are excluded from the calculation of the overall score. Sample descriptions for each type of rating are provided on an item-by-item basis in the measure's manual. The total score is obtained by dividing the summed scored per article by the total possible score (meaning 28 – [number of 'Not available' x 2]). Ten studies (12.3%) were double-rated by a second rater blind to the initial ratings, to establish the reliability of study quality ratings.

Data Collection and Synthesis

The following information was extracted from each included study: (1) authors, (2) year of publication, and (3) names of behavioural measures of social cognition. Measures were categorised according to social cognition subcategories and sorted by (a) their number of uses in studies and (b) first author of studies (excl. Table 1). Self-report and other-report assessments of social cognition potentially contained within studies were disregarded. In addition, data were extracted, if reported, on the behavioural measures' (4) validity and (5) reliability.

Results

In total, 81 articles met the inclusion criteria and were reviewed. Whether articles reported validity or reliability information is summarised in Table 1 (in alphabetic order). The articles' relevant findings are summarised in Table 2 (task descriptions), Table 3 (validity information), and Table 4 (reliability information). The task descriptions of measures without reliability or validity information are summarised in Table 5. Results were grouped according to this review's working definition of social cognition after TBI based on Henry and colleagues (2016), namely social perception, affective empathy, theory of mind, and social behaviour. Each measure was assigned their own ID number for consistency across tables (cf. Appendix 7).

Where no name for a given measure was provided, a brief description is given in square brackets. Prior use of measures in research is also reported according to the respective article, as opposed to the drawing on wider social cognition literature. If prior use is not clearly stated, but another article from the search results used as a reference, or prior use stated but not referenced, this is denoted with square brackets as "[Yes]."

There are different types of validity and reliability covered in the final search sample. Content validity refers to the examination of a test's content to ascertain whether it comprehensively covers the behaviour in question (Anastasi & Urbina, 1997b). A subtype of content validity is face validity, meaning whether a measure 'appears' valid, for instance to examinees or people who are going to use it. Criterion validity is concerned with the effectiveness of a measure to predict an outcome or an individual's performance in pre-defined activities, for example whether a social cognition measure predicts socially appropriate behaviour. Subtypes include concurrent and predictive validity, meaning to what extent a test correlates with performance outcomes in a concurrent versus a subsequent activity. Construct validity is defined as the extent to which a measure assesses a particular trait or theoretical construct. This can be assessed via internal consistency, meaning whether a score distinguishes between respondents in the same direction as the overall test. Convergent validity is concerned with whether a test correlates highly with another measure that it shares theoretical overlap with; discriminant validity, on the other hand, is concerned with whether a test has a poor correlation with another measure that it theoretically distinct from (Anastasi & Urbina, 1997b).

Sensitivity and specificity are terms originating from signal detection theory. Sensitivity refers to "the proportion of true positives that are correctly identified by the test", whereas specificity is defined as "the proportion of true negatives that are correctly identified by the test" (p. 1152, Altman & Bland, 1994). Both originate from signal detection theory (Altman & Bland, 1994) and are classified under validity for the purposes of this review.

Reliability is concerned with the extent to which an assessment tool is able to produce comparable results across consistent conditions (Anastasi & Urbina, 1997a). This can be examined via re-testing using the same measure with the same sample on separate occasions (test-retest reliability). Another option refers to examining a measure's outcome with a separate version of the same tool (alternate form reliability). Lastly, a measure's reliability can be assessed using different raters who examine the same construct (inter-rater, or scorer, reliability), as opposed to reliability within the same rater (intra-rater reliability).

Table 1. Behavioural assessment tools for social cognition in people with traumatic brain injury – overview.

Table 1

Overview

Measure ID Number	Assessment	Reliability Report Available	Validity Report Available
21	[Action comprehension task]	Yes	Not known
54	[Anger regulation task]	Not known	Not known
59	[Cartoons task based on collection from other studies]	Not known	Not known
19	[Computerised eye gaze task using cartoon drawings]	Yes	Yes
48	[Emotion recognition task based on affective prosody samples]	Not known	Not known
27	[Exchange structure analysis]	Not known	Yes
53	[Irony detection task using written scenarios]	Not known	Not known
30	[Observational measure of child compliance]	Not known	Yes
33	[Observational measure of social disinhibition]	Not known	Yes
64	[Recursive and non-recursive questions referring to videotaped scenario]	Not known	Not known
20	[Stories task based on collection from other studies]	Not known	Yes
13	[Task based on interpersonal transitive verbs]	Not known	Yes
47	[Task based on Montreal Set of Facial Displays of Emotion (MSFDE)]	Not known	Not known
45	[Task based on neutral vs. happy vs. sad baby faces]	Not known	Not known
23	[Task to elicit naturalistic speech production, high/low ToM conditions]	Yes	Yes
38	[Task(s) based on Ekman faces]	Not known	Not known
63	[Theory-of-mind task based on auditory/written scenarios]	Not known	Not known
68	[Unnamed battery]	Not known	Not known
52	[Unnamed sarcasm task]	Not known	Not known
22	[Video vignettes followed by low/high Theory-of-Mind questions]	Yes	Not known
65	Adapted Stories Task	Not known	Not known
51	Aprosodia Battery	Not known	Not known
25	Assessment Battery of Communication (ABaCo)	Yes	Yes
78	Assessment of Interpersonal Problem-Solving Skills (AIPSS)	Not known	Not known
74	Bangor Gambling Task (BGT)	Not known	Not known
18	Cartoon Test	Not known	Yes
62	Character Intention Task	Not known	Not known
70	Comprehension and metapragmatic-knowledge task	Not known	Not known

Table 1 (cont'd)

Overview

Measure ID Number	Assessment	Reliability Report Available	Validity Report Available
1	Diagnostic Assessment of Nonverbal Affect 2 - Adult Faces	Yes	Yes
2	Diagnostic Assessment of Nonverbal Affect 2 - Adult Paralanguage	Yes	Yes
6	Emotion Recognition Test (ERT)	Yes	Not known
12	Emotional Inference from Stories Test (EIST)	Yes	Yes
11	Emotion-in-Context Task (EIC)	Not known	Yes
35	Evaluation of Social Interaction (ESI)	Yes	Yes
46	Facial Emotion Identification Task (FEIT)	Not known	Not known
9	Facial Expression Matching Task	Not known	Yes
8	Facial Expression Naming Task	Not known	Yes
5	Facial Expressions of Emotion-Stimuli and Tests (FEEST)	Yes	Yes
56	False Belief Task	Not known	Not known
17	Faux-Pas Test	Yes	Yes
36	Florida Affect Battery (FAB)	Not known	Not known
3	Florida Affect Battery-Revised (FAB)	Yes	Yes
37	French Emotion Evaluation Task [French version of TASIT] / Awareness of Social Inferences Test (TASIT-short) [Dutch version]	Not known	Not known
24	Generic Structure Potential (GSP) of different problem-solving tasks	Not known	Yes
61	Hinting Task	Not known	Not known
49	Implicit Association Test (IAT)	Not known	Not known
76	Iowa Gambling Task	Not known	Not known
10	Karolinska Directed Emotional Faces test (KDEF)	Yes	Not known
14	Levels of Emotional Awareness Scale (LEAS)	Yes	Yes
31	Marital Interaction Coding System (MICS)	Not known	Yes
55	Mayer-Salovey-Caruso Emotional Intelligence Test (MSCEIT)	Not known	Not known
72	Mediated Discourse Elicitation Protocol (MDEP)	Not known	Not known
71	Montreal Evaluation of Communication (MEC) Protocol	Not known	Not known
67	Moving Shapes Paradigm	Not known	Not known

Table 1 (cont'd)

Overview

Measure ID Number	Assessment	Reliability Report Available	Validity Report Available
75	Prisoner's Dilemma Task	Not known	Not known
69	Production task: the interview	Not known	Not known
50	Prosodic Emotion Labelling Task	Not known	Not known
4	Reading the Mind in the Eyes Test	Yes	Not known
26	Relationship Closeness Induction Task (RCIT)	Not known	Yes
77	Risky-Gains Task	Not known	Not known
57	Sally and Ann Task	Not known	Not known
15	Sarcasm Comprehension/Mentalistic Interpretation Task	Yes	Yes
16	Self-Assessment Manikin (SAM)	Not known	Yes
60	Smarties Task	Not known	Not known
73	Social Decision Making Task (SDMT) with Cyberball Questionnaire	Not known	Not known
32	Social Disinhibition Task (SDT)	Not known	Yes
28	Social Problem Fluency Task	Not known	Yes
29	Social Problem Resolution Task	Not known	Yes
34	Social Problem-Solving Test (SPST)	Yes	Not known
58	Strange Stories Task	Not known	Not known
41	Task 1: "Expression labelling (context-free)"	Not known	Not known
7	Task 1: "Rating the intensity of basic emotions expressed by faces"	Yes	Not known
42	Task 2: "Matching expressions (context-free)"	Not known	Not known
39	Task 2: "Matching facial expressions with the names of basic emotions"	Not known	Not known
43	Task 3: "Semantic knowledge of emotions"	Not known	Not known
40	Task 3: "Sorting facial expressions into emotion categories"	Not known	Not known
44	Task 4: "Matching facial expressions to context and context-provided expression labelling"	Not known	Not known
66	Video Social Inference Test (VSIT)	Not known	Not known

Table 2. Behavioural assessment tools for social cognition in people with traumatic brain injury – task descriptions.

Table 2

Task Descriptions

Measure ID Number	Assessment	Studies	Means of Presentation	Means of Response	Prior Use in TBI Research
Social Perception – Multi-Modal Emotion Perception					
1	Diagnostic Assessment of Nonverbal Affect 2 - Adult Faces	Neumann et al. (2012, 2014, 2015); Radice-Neumann et al. (2009); Zupan et al. (2015, 2017)	Facial photographs with emotional expressions	Matching emotions from list using PC	Yes
2	Diagnostic Assessment of Nonverbal Affect 2 - Adult Paralanguage	Neumann et al. (2012, 2014); Radice-Neumann et al. (2009); Zupan et al. (2017)	Text and auditory stories	Matching emotions from list using PC	Yes
3	Florida Affect Battery-Revised (FAB)	Green et al. (2004)	Facial photographs with emotional expressions and emotion expressed via prosody	Emotion labelling; Emotion discrimination	Not stated
Social Perception – Facial Emotion Perception					
4	Reading the Mind in the Eyes Test	Geraci et al. (2010); Henry et al. (2006); Honan et al. (2015); McDonald et al. (2014); Milders et al. (2003); Muller et al. (2010); Saxton et al. (2013); Shu et al. (2014); Ubukata et al. (2014)	Photographs of facial eye regions with emotional expressions	Multiple-choice matching of emotion	Yes
5	Facial Expressions of Emotion-Stimuli and Tests (FEEST)	Spikman et al. (2012); Visser-Keizer et al. (2016); Westerhof-Evers et al. (2017); Williams et al. (2010)	Facial photographs with emotional expressions	Multiple-choice matching of emotion; Visser-Keizer et al. (2016) and Williams et al. (2010): using PC	Yes

* Osborne-Crowley and colleagues (2016) used a subset of the Emotion Recognition Test (ERT).

Table 2 (cont'd)

Task Descriptions

Measure ID Number	Assessment	Studies	Means of Presentation	Means of Response	Prior Use in TBI Research
Social Perception – Facial Emotion Perception					
6	Emotion Recognition Test (ERT)	Rigon et al. (2016); Osborne-Crowley et al. (2016)*	Facial animations with emotional expressions	Multiple-choice matching of emotion	Yes
7	Task 1: "Rating the intensity of basic emotions expressed by faces"	Adolphs et al. (2000)	Facial photographs with emotional expressions	Rating emotion intensity	Yes
8	Facial Expression Naming Task	Bornhofen et al. (2008)	Facial photographs with emotional expressions	Spoken emotion description	Not stated
9	Facial Expression Matching Task	Bornhofen et al. (2008)	Facial photographs with emotional expressions	Matching of expressions	Not stated
10	Karolinska Directed Emotional Faces test (KDEF)	Rigon et al. (2016)	Facial photographs with emotional expressions	Matching emotions from list using PC	Not stated
11	Emotion-in-Context Task (EIC)	Turkstra et al. (2017)	Facial photographs with emotional expressions	Typed emotion description of stimuli shown in online survey	No
Social Perception – Verbal Emotion Perception					
12	Emotional Inference from Stories Test (EIST)	Neumann et al. (2012, 2015a); Zupan et al. (2015, 2017)	Text and auditory stories shown on PC	Matching emotions from list	Yes
13	[Task based on interpersonal transitive verbs]	Dresang et al. (2018)	Sentence about social interaction shown on PC	Typed imagined rationale	No
14	Levels of Emotional Awareness Scale (LEAS)	Radice-Neumann et al. (2009)	Written stories	Description of emotion	Not stated

Table 2 (cont'd)

Task Descriptions

Measure ID Number	Assessment	Studies	Means of Presentation	Means of Response	Prior Use in TBI Research
Social Perception – Humour (Sarcasm)					
15	Sarcasm Comprehension/Mentalistic Interpretation Task	Channon et al. (2005, 2010)	Short (sarcastic) story shown on PC	Spoken rationale for character's intention	Not stated
Affective Empathy					
16	Self-Assessment Manikin (SAM)	De Sousa et al. (2010; 2012)	Emotional videos shown on PC	Selection of valence manikin from list	Yes
Theory of Mind					
17	Faux-Pas Test	Bivona et al. (2014, 2015); Cohen-Zimerman et al. (2017); Geraci et al. (2010); Kelly et al. (2014); Milders et al. (2003, 2006, 2008); Muller et al. (2010); Shamay-Tsoory et al. (2003, 2005); Spikman et al. (2012); Ubukata et al. (2014); Xi et al. (2011)	Written and auditory stories	Spoken response to questions	Yes
18	Cartoon Test	Milders et al. (2006, 2008); Spikman et al. (2012)	Scenarios in drawn cartoon format	Spoken response to questions	Yes
19	[Computerised eye gaze task using cartoon drawings]	Shamay-Tsoory and Aharon-Peretz (2007); Shamay-Tsoory et al. (2007)	Cartoon faces and targets with directional eye gaze shown on PC	Shamay-Tsoory et al. (2007): detection of gloating and envy; Shamay-Tsoory and Aharon-Peretz (2007): detection of false beliefs	Yes
20	[Stories task based on collection from other studies]	Bibby et al. (2005)	Auditory and written stories	Spoken response to questions	[Yes]

Table 2 (cont'd)

Task Descriptions

Measure ID Number	Assessment	Studies	Means of Presentation	Means of Response	Prior Use in TBI Research
Theory of Mind					
21	[Action comprehension task]	Channon et al. (2005)	Short story of action shown on PC	Spoken rationale for event or character	Not stated
22	[Video vignettes followed by low/high Theory-of-Mind questions]	Honan et al. (2015)	Video scenarios	Spoken response to questions	Not stated
23	[Task to elicit naturalistic speech production, high/low ToM conditions]	McDonald et al. (2014)	Photographs of holiday resorts	Spoken response to questions	No
Social Behaviour – Communication Skills					
24	Generic Structure Potential (GSP) of different problem-solving tasks	Kilov et al. (2009); Togher et al. (1997; 1999)	Not applicable	Social problem-solving and information-requesting; Kilov et al. (2009): with friend; Togher et al. (1997): with pretend phone operators Togher et al. (1999): with research and confederates	Yes
25	Assessment Battery of Communication (ABaCo)	Angeleri et al. (2008); Bosco et al. (2017)†	Video scenarios	Range of comprehension and production tasks	Yes

† Bosco and colleagues (2017) used a subset of the Assessment Battery of Communication (ABaCo).

Table 2 (cont'd)

Task Descriptions

Measure ID Number	Assessment	Studies	Means of Presentation	Means of Response	Prior Use in TBI Research
Social Behaviour – Communication Skills					
26	Relationship Closeness Induction Task (RCIT)	Byom et al. (2012)	Increasingly personal auditory questions	Spoken responses	Not stated
27	[Exchange structure analysis]	Sim et al. (2013)	Not applicable	Evaluation of video-taped interactions for verbal and non-verbal "moves"	Not stated
Social Behaviour – Social Skills					
28	Social Problem Fluency Task	Channon et al. (2010)	Written scenario	Spoken response to questions about 'awkward' situation and development of solutions	[Yes]
29	Social Problem Resolution Task	Channon et al. (2010)	Written scenario	Spoken response to question	[Yes]
30	[Observational measure of child compliance]	Ducharme et al. (2002)	Not applicable	Rating of video recordings for initiation of a request within specified time frame	Not stated
31	Marital Interaction Coding System (MICS)	Godfrey et al. (1991)	Not applicable	Video-taped assessment of naturalistic interactions by trained observer	Not stated

Table 2 (cont'd)

Task Descriptions

Social Behaviour – Social Skills					
Measure ID Number	Assessment	Studies	Means of Presentation	Means of Response	Prior Use in TBI Research
32	Social Disinhibition Task (SDT)	Honan et al. (2017)	Photographic scenarios with accompanying text	Spoken response to questions about 'awkward' stories	Not stated
33	[Observational measure of social disinhibition]	Osborne-Crowley et al. (2016)	Not applicable	Spoken response to questions about personal experiences, rated for level of self-disclosure	[Yes]
34	Social Problem-Solving Test (SPST)	Robertson et al. (2008)	Video scenario	Spoken response to questions and role-play of social problem-solving	Not stated
35	Evaluation of Social Interaction (ESI)	Simmons et al. (2010)	Not applicable	Scoring of two social interactions selected by participant	Not stated

Table 3. Behavioural assessment tools for social cognition in people with traumatic brain injury – validity.

Table 3

Validity

Social Perception – Multi-Modal Emotion Perception

Measure ID Number	Assessment	Studies	Type of Validity	Validity Wording	Source
1	Diagnostic Assessment of Nonverbal Affect 2 - Adult Faces	Neumann et al. (2012, 2014, 2015); Radice-Neumann et al. (2009); Zupan et al. (2015, 2017)	Criterion / construct validity	Neumann et al. (2012, 2014, 2015); Zupan et al. (2017): "correlates well" with measures of affect recognition, personality, and social compentence; Radice-Neumann et al. (2009): *r* = 0.80 with Japanese and Caucasian Facial Expressions of Emotion test	References
2	Diagnostic Assessment of Nonverbal Affect 2 - Adult Paralanguage	Neumann et al. (2012, 2014); Radice-Neumann et al. (2009); Zupan et al. (2017)	Face validity	Neumann et al. (2012): "The DANVA2-AP is a widely used measure across all races, sexes, ages, and populations, including TBI."	Author report
			Criterion / construct validity	Neumann et al. (2014): "correlates well" with measures of personality and social compentence	Reference

Table 3 (cont'd)

Validity

Measure ID Number	Assessment	Studies	Type of Validity	Validity Wording	Source
Social Perception – Multi-Modal Emotion Perception					
3	Florida Affect Battery-Revised (FAB)	Green et al. (2004)	Criterion / construct validity	"The battery has been validated as a measure of emotion perception deficits in a variety of brain-disordered patients, including stroke and Parkinson's patients (Bowers, Bauer, & Heilman, 1993; Bowers, Blonder, Feinberg, & Heilman, 1991; Bowers et al., 1989)."	References
Social Perception – Facial Emotion Perception					
4	Reading the Mind in the Eyes Test	Geraci et al. (2010); Henry et al. (2006); Honan et al. (2015); McDonald et al. (2014); Milders et al. (2003); Muller et al. (2010); Saxton et al. (2013); Shu et al. (2014); Ubukata et al. (2014)	Discriminant validity	McDonald et al. (2014): "[The Eyes Test is] proven to be sensitive to group differences (Geraci et al., 2010; Havit-Thomassin et al., 2006; Henry et al., 2006; Tursktra et al., 2008)."	References
5	Facial Expressions of Emotion-Stimuli and Tests (FEEST)	Spikman et al. (2012); Visser-Keizer et al. (2016); Westerhof-Evers et al. (2017); Williams et al. (2010)	[Not specified]	Williams et al. (2010): "The reliability and validity of items in the test have been demonstrated (Young et al., 2002)."	Reference

Table 3 (cont'd)

Validity

Social Perception – Facial Emotion Perception

Measure ID Number	Assessment	Studies	Type of Validity	Validity Wording	Source
6	Emotion Recognition Test (ERT)	Rigon et al. (2016); Osborne-Crowley et al. (2016)*	Construct validity	Rigon et al. (2016): [correlated with neuropsychological measures]	Author report
7	Task 1: "Rating the intensity of basic emotions expressed by faces"	Adolphs et al. (2000)	Discriminant validity	"The possible dependence of performance in [task 1] with respect to background neuropsychology and demographics was examined with an interactive stepwise linear regression model."	Author report
8	Facial Expression Naming Task	Bornhofen et al. (2008)	Not stated	Not stated	Not stated
9	Facial Expression Matching Task	Bornhofen et al. (2008)	Not stated	Not stated	Not stated
10	Karolinska Directed Emotional Faces test (KDEF)	Rigon et al. (2016)	Construct validity	Rigon et al. (2016): [correlated with neuropsychological measures]	Author report
11	Emotion-in-Context Task (EIC)	Turkstra et al. (2017)	Not stated	Not stated	Not stated

* Osborne-Crowley et al. (2016) used a subset of the Emotion Recognition Test (ERT).

Table 3 (cont'd)

Validity

Social Perception – Verbal Emotion Perception

Measure ID Number	Assessment	Studies	Type of Validity	Validity Wording	Source
12	Emotional Inference from Stories Test (EIST)	Neumann et al. (2012, 2015a); Zupan et al. (2015, 2017)	Face validity	Neumann et al. (2012): health participant agreement 74-100% for happy stories, 72-92% for sad stories, 92-97% for angry stories, 84-87% for fearful stories; Neumann et al. (2015): 90-100% for version 1, 70-100% for version 2	Reference
			Construct validity	Zupan et al. (2015): correlated with DANVA2-AF; version 1 – $r = 0.50$, $p < 0.001$; version 2 – $r = 0.31$, $p < 0.001$	Author report
13	[Task based on interpersonal transitive verbs]	Dresang et al. (2018)	Not stated	Not stated	Not stated
14	Levels of Emotional Awareness Scale (LEAS)	Radice-Neumann et al. (2009)	Criterion / construct validity	"[The LEAS] was significantly correlated with other measures of emotion perception."	Reference

Table 3 (cont'd)

Validity

Measure ID Number	Assessment	Studies	Type of Validity	Validity Wording	Source
Social Perception – Humour (Sarcasm)					
15	Sarcasm Comprehension/Mentalistic Interpretation Task	Channon et al. (2005, 2010)	Face validity	Channon et al. (2005): [sarcastic and control items distinguishable by healthy participants; no sig. difference in item difficulty]	Author report
Affective Empathy					
16	Self-Assessment Manikin (SAM)	De Sousa et al. (2010; 2012)	Not stated	Not stated	Not stated
Theory of Mind					
17	Faux-Pas Test	Bivona et al. (2014, 2015); Cohen-Zimerman et al. (2017); Geraci et al. (2010); Kelly et al. (2014); Milders et al. (2003, 2006, 2008); Muller et al. (2010); Shamay-Tsoory et al. (2003, 2005); Spikman et al. (2012); Ubukata et al. (2014); Xi et al. (2011)	Discriminant validity	Milders et al. (2008): "The score referring to understanding of intentions in the 10 vignettes with faux pas was taken as the measure of performance on this task, as this score discriminated between patients and controls (see Milders et al., 2006, for more details on the results of his task.)"	Reference

Table 3 (cont'd)

Validity

Theory of Mind

Measure ID Number	Assessment	Studies	Type of Validity	Validity Wording	Source
18	Cartoon Test	Milders et al. (2006, 2008); Spikman et al. (2012)	Not stated	Not stated	Not stated
19	[Computerised eye gaze task using cartoon drawings]	Shamay-Tsoory and Aharon-Peretz (2007); Shamay-Tsoory et al. (2007)	Face validity	Shamay-Tsoory et al. (2007): "81% of the sample chose the indented [sic] emotion"	Author report
20	[Stories task based on collection from other studies]	Bibby et al. (2005)	Not stated	Not stated	Not stated
21	[Action comprehension task]	Channon et al. (2005)	Face validity	[Mentalistic action and physical event items distinguishable by healthy participants; no sig. difference in response times]	Author report
22	[Video vignettes followed by low/high Theory-of-Mind questions]	Honan et al. (2015)	Construct validity	[Regression equation (with three TASIT subtest and Mind-in-the-Eyes total scores) not significant for low-ToM ($p = 0.29$), but significant for high-ToM task, $R = 0.61$, $F(4, 43) = 6.42$, $p < 0.001$]	Author report

Table 3 (cont'd)

Validity

Measure ID Number	Assessment	Studies	Type of Validity	Validity Wording	Source
Theory of Mind					
23	[Task to elicit naturalistic speech production, high/low ToM conditions]	McDonald et al. (2014)	Convergent Validity	"[T]wo of the three high ToM versions of the [executive functioning (EF)] tasks predicted unique variance with TASIT Part 3, and for the third (low EF) there was a similar trend. The high inhibition high ToM task predicted unique variance on the three other ToM tests [TASIT Parts 1, 2; Mind-in-the-Eyes test] as well."	Author report
Social Behaviour – Communication Skills					
24	Generic Structure Potential (GSP) of different problem-solving tasks	Kilov et al. (2009); Togher et al. (1997; 1999)	Not stated	Not stated	Not stated
25	Assessment Battery of Communication (ABaCo)	Angeleri et al. (2008); Bosco et al. (2017)†	Construct validity	"Good construct validity" (Sacco et al., 2008)	Reference
26	Relationship Closeness Induction Task (RCIT)	Byom et al. (2012)	Not stated	Not stated	Not stated
27	[Exchange structure analysis]	Sim et al. (2013)	Not stated	Not stated	Not stated

† Bosco and colleagues (2017) used a subset of the Assessment Battery of Communication (ABaCo).

Table 3 (cont'd)

Validity

Social Behaviour – Social Skills

Measure ID Number	Assessment	Studies	Type of Validity	Validity Wording	Source
28	Social Problem Fluency Task	Channon et al. (2010)	Not stated	Not stated	Not stated
29	Social Problem Resolution Task	Channon et al. (2010)	Not stated	Not stated	Not stated
30	[Observational measure of child compliance]	Ducharme et al. (2002)	Not stated	Not stated	Not stated
31	Marital Interaction Coding System (MICS)	Godfrey et al. (1991)	Not stated	Not stated	Not stated
32	Social Disinhibition Task (SDT)	Honan et al. (2017)	Not stated	Not stated	Not stated
33	[Observational measure of social disinhibition]	Osborne-Crowley et al. (2016)	Not stated	Not stated	Not stated
34	Social Problem-Solving Test (SPST)	Robertson et al. (2008)	Concurrent validity	[SPST correlated with Verbal Reasoning and Judgement subtest from Cognitive Competency Test, Request Production Task, Everyday Problem Solving Inventory, New Tower of London, Alternate Uses Test, and Modified Six Elements Test]	Author report
35	Evaluation of Social Interaction (ESI)	Simmons et al. (2010)	Discriminant validity	"Simmons et al. (2010) have established that the ESI measure is sensitive enough to distinguish between those who have and those who do not have a disability."	Reference

Table 4. Behavioural assessment tools for social cognition in people with traumatic brain injury – reliability.

Table 4

Reliability

Social Perception – Multi-Modal Emotion Perception

Measure ID Number	Assessment	Studies	Type of Reliability	Reliability Wording	Source
1	Diagnostic Assessment of Nonverbal Affect 2 - Adult Faces	Neumann et al. (2012, 2014, 2015); Radice-Neumann et al. (2009); Zupan et al. (2015, 2017)	Test-retest reliability	Neumann et al. (2015); Zupan et al. (2017): "good"/"high" test-retest reliability; Radice-Neumann et al. (2009): *r* = 0.81 with a TBI population	Test-retest reliability
			Norming	Neumann et al. (2012): "[The DANVA2-AF] is a standardised test with age-related norms."	Author report + Reference
2	Diagnostic Assessment of Nonverbal Affect 2 - Adult Paralanguage	Neumann et al. (2012, 2014); Radice-Neumann et al. (2009); Zupan et al. (2017)	Test-retest reliability	Neumann et al. (2012); Radice-Neumann et al. (2009): *r* = 0.73-0.93 in a study of 3 different age groups over 4 weeks	Author report + Reference
3	Florida Affect Battery-Revised (FAB)	Green et al. (2004)	Test-retest reliability	*r* = 0.89-0.97 in college students and adults in early 50s over 2 weeks (Bowers, Blonder, & Hellman, 1999).	Reference

Table 4 (cont'd)

Reliability

Social Perception – Facial Emotion Perception

Measure ID Number	Assessment	Studies	Type of Reliability	Reliability Wording	Source
4	Reading the Mind in the Eyes Test	Geraci et al. (2010); Henry et al. (2006); Honan et al. (2015); McDonald et al. (2014); Milders et al. (2003); Muller et al. (2010); Saxton et al. (2013); Shu et al. (2014); Ubukata et al. (2014)	Not stated	Not stated	Not stated
5	Facial Expressions of Emotion-Stimuli and Tests (FEEST)	Spikman et al. (2012); Visser-Keizer et al. (2016); Westerhof-Evers et al. (2017); Williams et al. (2010)	[Not specified]	Williams et al. (2010): "The reliability and Reliability of items in the test have been demonstrated (Young et al., 2002)."	Reference
6	Emotion Recognition Test (ERT)	Rigon et al. (2016); Osborne-Crowley et al. (2016)*	Not stated	Not stated	Not stated
7	Task 1: "Rating the intensity of basic emotions expressed by faces"	Adolphs et al. (2000)	Not stated	Not stated	Not stated
8	Facial Expression Naming Task	Bornhofen et al. (2008)	Alternate form	$r = 0.75$, $p < 0.01$	Author report
9	Facial Expression Matching Task	Bornhofen et al. (2008)	Alternate form	$r = 0.67$, $p < 0.05$	Author report
10	Karolinska Directed Emotional Faces test (KDEF)	Rigon et al. (2016)	Not stated	Not stated	Not stated
11	Emotion-in-Context Task (EIC)	Turkstra et al. (2017)	Inter-rater reliability	89% (study 2; independent rater blinded to photo condition)	Author report

* Osborne-Crowley et al. (2016) used a subset of the Emotion Recognition Test (ERT).

Table 4 (cont'd)

Reliability

Measure ID Number	Assessment	Studies	Type of Reliability	Reliability Wording	Source
Social Perception – Verbal Emotion Perception					
12	Emotional Inference from Stories Test (EIST)	Neumann et al. (2012, 2015a); Zupan et al. (2015, 2017)	Test-retest reliability	Zupan et al. (2015): version 1 – $r = 0.76$, $p < 0.001$; version 2 – $r = 0.72$, $p < 0.001$	Author report
13	[Task based on interpersonal transitive verbs]	Dresang et al. (2018)	Inter-rater reliability	98%	Author report
14	Levels of Emotional Awareness Scale (LEAS)	Radice-Neumann et al. (2009)	Inter-rater reliability	$r = 0.84$	Reference
Social Perception – Humour (Sarcasm)					
15	Sarcasm Comprehension/Mentalistic Interpretation Task	Channon et al. (2005, 2010)	Inter-rater reliability	Channon et al. (2010): 95%	Author report
			Internal consistency	Channon et al. (2010): Cronbach's $\alpha = 0.62$	Author report
Affective Empathy					
16	Self-Assessment Manikin (SAM)	De Sousa et al. (2010; 2012)	Not specified	De Sousa et al. (2012): "[The SAM] has demonstrated high reliability for both valence and arousal dimensions ($r = 0.94$ and 0.93, respectively, for 21 pictures; Lang, Bradley, & Cuthbert, 1999)."	Reference

Table 4 (cont'd)

Reliability

Theory of Mind

Measure ID Number	Assessment	Studies	Type of Reliability	Reliability Wording	Source
17	Faux-Pas Test	Bivona et al. (2014, 2015); Cohen-Zimerman et al. (2017); Geraci et al. (2010); Kelly et al. (2014); Milders et al. (2003, 2006, 2008); Muller et al. (2010); Shamay-Tsoory et al. (2003, 2005); Spikman et al. (2012); Ubukata et al. (2014); Xi et al. (2011)	Inter-rater reliability	Milders et al. (2006): *r* = 0.97	Author report
18	Cartoon Test	Milders et al. (2006, 2008); Spikman et al. (2012)	Inter-rater reliability	Milders et al. (2006): *r* = 0.87	Author report
19	[Computerised eye gaze task using cartoon drawings]	Shamay-Tsoory and Aharon-Peretz (2007); Shamay-Tsoory et al. (2007)	Inter-rater reliability	Shamay-Tsoory et al. (2007): "A subset of stimuli was selected, based on a high degree (>85%) of agreement among raters."	Author report
20	[Stories task based on collection from other studies]	Bibby et al. (2005)	Test-retest reliability	"Good reliability" (Hughes et al., 2000)	Reference
21	[Action comprehension task]	Channon et al. (2005)	Not stated	Not stated	Not stated
22	[Video vignettes followed by low/high Theory-of-Mind questions]	Honan et al. (2015)	Not stated	Not stated	Not stated

Table 4 (cont'd)

Reliability

Measure ID Number	Assessment	Studies	Type of Reliability	Reliability Wording	Source
Theory of Mind					
23	[Task to elicit naturalistic speech production, high/low ToM conditions]	McDonald et al. (2014)	Inter-rater reliability	Cronbach's α = 0.88 (high ToM/low executive functioning) Cronbach's α = 0.87 (high ToM/high flexibility) Cronbach's α = 0.82 (high ToM/high inhibition)	Inter-rater reliability
Social Behaviour – Communication Skills					
24	Generic Structure Potential (GSP) of different problem-solving tasks	Kilov et al. (2009); Togher et al. (1997; 1999)	Inter-rater reliability	Kilov et al. (2009): 77% *Intra*-rater reliability: 92% Togher et al. (1997): 90.4% Togher et al. (1999): 94.7%	Inter-rater reliability
25	Assessment Battery of Communication (ABaCo)	Angeleri et al. (2008); Bosco et al. (2017)†	Inter-rater reliability	"High inter-rater reliability" (Sacco et al., 2008)	Reference
			Internal consistency	"Good internal consistency" (Sacco et al., 2008)	Reference
26	Relationship Closeness Induction Task (RCIT)	Byom et al. (2012)	Inter-rater reliability	83.03% (for mental state terms)	Author report
27	[Exchange structure analysis]	Sim et al. (2013)	Inter-rater reliability	83.03% (SD = 3.09; for assigning K1, K2, and dynamic 'moves')	Author report

† Bosco and colleagues (2017) used a subset of the Assessment Battery of Communication (ABaCo).

Table 4 (cont'd)

Reliability

Social Behaviour – Social Skills

Measure ID Number	Assessment	Studies	Type of Reliability	Reliability Wording	Source
28	Social Problem Fluency Task	Channon et al. (2010)	Inter-rater reliability	92%	Author report
			Internal consistency	Cronbach's α = 0.67	Author report
29	Social Problem Resolution Task	Channon et al. (2010)	Inter-rater reliability	92%	Author report
			Internal consistency	Cronbach's *α* = 0.58	Author report
30	[Observational measure of child compliance]	Ducharme et al. (2002)	Inter-rater reliability	Parent-therapist: 92% (baseline) / 98% (treatment, generalization, & follow-up) Videotape-therapist: 92% / 93% Videotape-parent: 85% / 92%	Inter-rater reliability
31	Marital Interaction Coding System (MICS)	Godfrey et al. (1991)	Inter-rater reliability	75%	Author report
32	Social Disinhibition Task (SDT)	Honan et al. (2017)	Inter-rater reliability	~99.4% (<10 ambiguous responses for N = 53, 30 items each)	Author report
33	[Observational measure of social disinhibition]	Osborne-Crowley et al. (2016)	Inter-rater reliability	Cronbach's *α* = 0.69 (Barker, Pistrang, & Elliott, 1994)	Reference
34	Social Problem-Solving Test (SPST)	Robertson et al. (2008)	Not stated	Not stated	Not stated

Table 4 (cont'd)

Reliability

Social Behaviour – Social Skills

Measure ID Number	Assessment	Studies	Type of Reliability	Reliability Wording	Source
35	Evaluation of Social Interaction (ESI)	Simmons et al. (2010)	Inter-rater reliability	"Simmons et al. (2010) [verified] the reliability of raters once they have gone through a training course to learn administration and scoring criteria."	Reference

Table 5. Behavioural assessment tools for social cognition in people with traumatic brain injury – without reported validity or reliability.

Table 5

Task Descriptions (Tasks without Reported Validity or Reliability)

Social Perception – Multi-Modal Emotion Perception

Measure ID Number	Assessment	Studies	Means of Presentation	Means of Response	Prior Use in TBI Research
36	Florida Affect Battery (FAB)	Milders et al. (2003, 2008); Struchen et al. (2008)	Facial photographs with emotional expressions and emotion expressed via prosody	Emotion labelling; Emotion discrimination	Yes
37	French Emotion Evaluation Task [French version of TASIT] / Awareness of Social Inferences Test (TASIT-short) [Dutch version]	Aboulafia-Brakha et al. (2016) / Westerhof-Evers et al. (2017)	Presentation of film vignettes depicting emotional expressions, lies, and sarcasm	Emotion recognition	Not stated

Table 5 (cont'd)

Task Descriptions (Tasks without Reported Validity or Reliability)

Social Perception – Facial Emotion Perception

Measure ID Number	Assessment	Studies	Means of Presentation	Means of Response	Prior Use in TBI Research
38	[Task(s) based on Ekman faces]	Callahan et al. (2011); Henry et al. (2006); Lew et al. (2005); McDonald et al. (2011a, b, c); Milders et al. (2003, 2008); Shamay-Tsoory et al. (2003, 2004, 2005, 2007); Ubukata et al. (2014)	Facial photographs with emotional expressions	"Callahan et al. (2011): rating emotion intensity; Henry et al. (2006), Ubukata et al. (2014): matching emotions from list; Lew et al. (2005): identifying target emotion; Milders et al. (2003, 2008): matching of emotions from list, matching of expressions, and matching expressions to situations; Shamay-Tsoory et al. (2003, 2004, 2005, 2007): spoken emotion description"	Yes
39	Task 2: "Matching facial expressions with the names of basic emotions"	Adolphs et al. (2000)	Facial photographs with emotional expressions	Matching emotions from list	Yes

Table 5 (cont'd)

Task Descriptions (Tasks without Reported Validity or Reliability)

Social Perception – Facial Emotion Perception

Measure ID Number	Assessment	Studies	Means of Presentation	Means of Response	Prior Use in TBI Research
40	Task 3: "Sorting facial expressions into emotion categories"	Adolphs et al. (2000)	Facial photographs with emotional expressions	Sorting into piles based on emotional similarity	No
41	Task 1: "Expression labelling (context-free)"	Croker et al. (2005)	Facial photographs with emotional expressions	Matching emotions from list	No
42	Task 2: "Matching expressions (context-free)"	Croker et al. (2005)	Facial photographs with emotional expressions	Matching of expressions	No
43	Task 3: "Semantic knowledge of emotions"	Croker et al. (2005)	Verbal stories	Matching of emotion labels	No
44	Task 4: "Matching facial expressions to context and context-provided expression labelling"	Croker et al. (2005)	Facial photographs with emotional expressions	Matching of expressions	No
45	[Task based on neutral vs. happy vs. sad baby faces]	Doi et al. (2007)	Facial photographs of babies with emotional expressions	Detection of expressions using PC	No
46	Facial Emotion Identification Task (FEIT)	Genova et al. (2017)	Facial photographs with emotional expressions	Emotion labelling; Emotion discrimination (same versus different)	No
47	[Task based on Montreal Set of Facial Displays of Emotion (MSFDE)]	Saxton et al. (2013)	Facial photographs with emotional expressions on PC screen	Verbal labelling of stimuli	Not stated

Table 5 (cont'd)

Task Descriptions (Tasks without Reported Validity or Reliability)

Measure ID Number	Assessment	Studies	Means of Presentation	Means of Response	Prior Use in TBI Research
Social Perception – Verbal Emotion Perception					
48	[Emotion recognition task based on affective prosody samples]	Shamay-Tsoory et al. (2003, 2004, 2005)	Auditory sentences	Matching emotions from list	Yes
49	Implicit Association Test (IAT)	Forbes et al. (2012); McDonald et al. (2011d)	Gender or stereotype labels shown on PC	Target selection	Yes
50	Prosodic Emotion Labelling Task	McDonald et al. (2013)	Auditory stories	Matching emotions using button press	[Yes]
Social Perception – Humour (Sarcasm)					
51	Aprosodia Battery	Davis et al. (2016)	Auditory sentences	Spoken decision between neutral/sarcastic tone	Not stated
52	[Unnamed sarcasm task]	Shamay-Tsoory et al. (2005)	Auditory story	Spoken response to factual and attitude questions	Not stated
53	[Irony detection task using written scenarios]	Shamay-Tsoory et al. (2007)	Written stories	Spoken response to theory-of-mind question about ironic/neutral sentence	Not stated

Table 5 (cont'd)

Task Descriptions (Tasks without Reported Validity or Reliability)

Measure ID Number	Assessment	Studies	Means of Presentation	Means of Response	Prior Use in TBI Research
Affective Empathy					
54	[Anger regulation task]	Aboulafia-Brakha et al. (2016)	Imagined social event	Rating of subjective anger and skin conductance	No
55	Mayer-Salovey-Caruso Emotional Intelligence Test (MSCEIT)	Cohen-Zimerman et al. (2017)	Not stated	Assessment of emotion-related competencies through performance tasks	Not stated
Theory of Mind					
56	False Belief Task	Muller et al. (2010); Shamay-Tsoory et al. (2007)	Written stories	Spoken response to questions	Yes
57	Sally and Ann Task	Bosco et al. (2017); Gabbatore et al. (2015)	Scenario acted out with two paper dolls	Spoken response to false-belief question	Yes
58	Strange Stories Task	Bosco et al. (2017); Gabbatore et al. (2015)‡	Auditory mentalistic stories	Spoken response to questions	Yes
59	[Cartoons task based on collection from other studies]	Bibby et al. (2005)	Scenarios in drawn cartoon format	Spoken response to questions	Not stated
60	Smarties Task	Bosco et al. (2017)	Smarties' sweet box with pen inside	Spoken response to false-belief question	Not stated
61	Hinting Task	Kelly et al. (2014)	Written and auditory false-belief stories	Spoken response to questions	Not stated
62	Character Intention Task	Muller et al. (2010)	Scenarios in drawn cartoon format	Selection of answer card to match with logical conclusion	Not stated

‡ Bosco and colleagues (2017) used a subset of the Strange Stories Task.

Table 5 (cont'd)

Task Descriptions (Tasks without Reported Validity or Reliability)

Measure ID Number	Assessment	Studies	Means of Presentation	Means of Response	Prior Use in TBI Research
Theory of Mind					
63	[Theory-of-mind task based on auditory/written scenarios]	Neumann et al. (2015b)	Written and auditory scenarios	Rating of own emotion on Likert scales	Yes
64	[Recursive and non-recursive questions referring to videotaped scenario]	Santoro et al. (1994)	Video scenarios	Response to questions using cartoon cards	Not stated
65	Adapted Stories Task	Saxton et al. (2013)	Written scenarios	Spoken response to questions	[Yes]
66	Video Social Inference Test (VSIT)	Turkstra et al. (2018)	Video scenarios	Spoken response to question	Yes
67	Moving Shapes Paradigm	Ubukata et al. (2014)	Interaction of triangle shapes shown on PC	Scoring of participants' verbal description	No
Social Behaviour – Communication Skills					
68	[Unnamed battery]	Bara et al. (1997)	Video scenarios	Spoken response to comprehension question	Not stated
69	Production task: the interview	Dardier et al. (2011)	Not applicable	Spoken responses in interview about participant's leisure activities and tastes	Not stated

Table 5 (cont'd)

Task Descriptions (Tasks without Reported Validity or Reliability)

Measure ID Number	Assessment	Studies	Means of Presentation	Means of Response	Prior Use in TBI Research
Social Behaviour – Communication Skills					
70	Comprehension and metapragmatic-knowledge task	Dardier et al. (2011)	Photographic scenario	Spoken response to comprehension and justification questions	[Yes]
71	Montreal Evaluation of Communication (MEC) Protocol	Muller et al. (2010)	Auditory scenario sentences	Spoken response to question	Not stated
72	Mediated Discourse Elicitation Protocol (MDEP)	Turkstra et al. (2012)	Not applicable	Conversation, story-telling, picture description, and procedure description tasks	Not stated
Social Behaviour – Emotional Decision-Making					
73	Social Decision Making Task (SDMT) with Cyberball Questionnaire	Kelly et al. (2013, 2014, 2017)	PC-simulated ball game	Button press responses to other players' behaviours; completion of CQ about fundamental needs, concurrent mood, and for manipulation check	Not stated
74	Bangor Gambling Task (BGT)	Adlam et al. (2017)	Playing cards	Selection of card depending on reward	Not stated
75	Prisoner's Dilemma Task	Johnstone et al. (2015)	Empathy/altruism task on PC	Button press for cooperation or defection	Not stated

Table 5 (cont'd)

Task Descriptions (Tasks without Reported Validity or Reliability)

Measure ID Number	Assessment	Studies	Means of Presentation	Means of Response	Prior Use in TBI Research
Social Behaviour – Emotional Decision-Making					
76	Iowa Gambling Task	Xi et al. (2011)	Playing cards shown on PC	Card selection based on simulated gains and losses	Not stated
77	Risky-Gains Task	Xi et al. (2011)	Numbers shown on PC	Number selection based on simulated in-game reward	Not stated
Social Behaviour – Social Skills					
78	Assessment of Interpersonal Problem-Solving Skills (AIPSS)	Struchen et al. (2011)	Video scenarios	Spoken and role-played responses to problem-related questions	No

Quality Assessment

The full quality ratings are listed in Appendix 6. The mean quality rating obtained using the QualSyst tool (Kmet et al., 2004) across the 81 final studies was M = 0.91 (SD = 0.06; range: 0.77-1.00). Inter-rater agreement of 82.1% was achieved.

The most common reasons that studies did not meet a criterion ("no" rating) were that investigator blinding would have been available or was possibly done but was not reported (5 out of 81 studies), estimates of variance (e.g. standard errors, confidence intervals) were not reported (4 studies) or confounding variables were not considered but could have influenced results (2 studies). The most common reasons, with some margin, that studies only met a "partial" instead of a full criterion ("yes" rating) were that sample sizes were difficult to assess (e.g. appeared small and no power calculation provided; 39 out of 82 studies), selection criteria (e.g. inclusion/exclusion criteria) were not described comprehensively but did not appear inappropriate (29 studies) or once more, that control for confounding variables (e.g. participants' baseline characteristics) was either done in an incomplete manner or stated but not described in detail (24 studies).

Assessment Tools

Overall, the review identified at least 78 distinct assessment tools for social cognition after TBI (Appendix 7).[1] Measures which were used in at least two studies and with good reliability and/or validity, unless states otherwise, are described in more detail below.

Social perception: multi-modal social perception.

Tools in this category assessed social perception after TBI in various ways. The task types encompassed facial emotion discrimination or matching as well as associating appropriate emotions to brief verbal or written expressions. Five studies in this category applied to the group of Neumann and colleagues (Neumann et al., 2012, 2014, 2015; Radice-Neumann et al., 2009; Zupan et al., 2015). One measure used across the studies was the Diagnostic Assessment of Nonverbal Affect 2 (DANVA-2; Nowicki Jr. & Duke, 1994). It requires participants to match the correct emotion (happy, sad, angry or fearful) to people's facial expressions on a computer screen (Adult Faces subsection) or short sentences spoken in a neutral tone (Adult Paralanguage subsection). The measure offers good construct validity and test-retest reliability, as referenced by the authors.

[1] Assessment tools which, for example, used Ekman and Friesen faces or collated social stories from different measures were combined for this count.

An additional measure with good validity and reliability was the Florida Affect Battery-Revised (Bowers et al., 1989, 1998) used by Green and colleagues (2004). Participants were required to name the facial emotion as demonstrated by the black-and-white photographic image of a female and to distinguish whether two photographic images showed the same or different emotional expressions. The full battery also assesses clients' ability to identify emotion from verbal intonation (Milders et al., 2003, 2008; Struchen et al., 2008).

Social perception: facial emotion perception.

Facial perception is essential to social cognition in terms of recognizing the identity of one's interaction partner, their emotions and emotional gradations (Fugate, 2013; A. M. Martinez, 2017).

The Ekman and Friesen series of photographs displaying facial expressions has a long-standing history in emotion and social cognition research (Ekman & Friesen, 1976; Tracy & Randles, 2011). Ekman focussed on six emotions (afraid, angry, disgusted, happy, sad, surprised) which he argued were both basic (Ekman, 1992) and universal (Ekman, 1970). Other authors have argued both against the notion of the universality of the list of emotions (Biehl et al., 1997) as well as made recommendations for other emotions to be included (Sabini & Silver, 2005). Support for the canonical nature of emotional responses to situations comes from a study by Kragel, Reddan, LaBar, and Wager (2019) who mapped a series of 20 emotions to activations in the visual cortices of 18 participants viewing affective scenes using functional magnetic resonance imaging. In this review, 13 studies used Ekman faces, the second most common task after the Faux Pas Test. Researchers had participants rate the intensity of Ekman faces (Callahan et al., 2011), identify or label the depicted emotional expressions (Henry et al., 2006; Lew et al., 2005; Shamay-Tsoory et al., 2003, 2004, 2005, 2007; Ubukata et al., 2014) or match them to situations or other expressions (Milders, 2008; Milders et al., 2003, 2008). However, none of the studies offered information on the validity or reliability of their tasks.

The "Reading the Mind in the Eyes" test (or briefly, RMET) was developed by Baron-Cohen and colleagues to identify social cognition deficits in children and young people with autism spectrum diagnoses relative to age-matched controls (2001; Baron-Cohen et al., 1997). It is often classed as a standard assessment tool for theory of mind (Geraci et al., 2010; Henry et al., 2006; Honan, McDonald, Gowland, Fisher, & Randall, 2015; McDonald et al., 2014; Muller et al., 2010; Saxton, Younan, & Lah, 2013; Ubukata et al., 2014). However, the measure is categorized under facial emotion perception for the purpose of the present review, as this is its primary function (Baron-Cohen et al., 2001; Baron-Cohen et al., 1997). The test requires participants to identify people's emotions from cropped photographs of the eyes only, in a four-alternative forced choice format. Children and young people with

diagnoses of autism or Asperger's disorder performed significantly worse compared to age-matched controls, though their performance was not significantly different on the Strange Stories task (Happé, 1994), another social cognition measure. Their performance was also not significantly different on identifying gender from cropped as well as emotions from full facial photos (Baron-Cohen et al., 1997). In the present review, most studies that compared participants' performance in those with TBI compared to those without TBI found a significantly lower score in the former group (Geraci et al., 2010; Henry et al., 2006; Honan et al., 2015; McDonald et al., 2014; Muller et al., 2010). Ubukata and colleagues (2014) also found that participants with TBI fared worse compared to healthy controls (M_{TBI} = 50.8, SD_{TBI} = 9.4; M_{HC} = 67.6, SD_{HC} = 5.9); however, they did not report a hypothesis test. A *t*-score could also not be calculated after the fact, as the size of the control group was not reported (Ubukata et al., 2014). Shu and colleagues (2014) did not find a difference between two groups of participants with TBI on the RMET, one with post-traumatic stress disorder, the other without (p = 0.65). One study (Milders et al., 2006) did not find a significant difference in performance on the RMET between participants with TBI and those without (p = 0.62); a rationale was not offered and lesion sites were not specified. McDonald and colleagues (2014) commented on the discriminant validity obtained for the measure in previous articles (Geraci et al., 2010; Havet-Thomassin et al., 2006; Henry et al., 2006; Turkstra et al., 2008).

The Facial Expressions of Emotion-Stimuli and Tests (FEEST) was employed in research by Spikman and colleagues (2012), Visser-Keizer and colleagues (2016), Westerhof-Evers and colleagues (2017), as well as Williams and Wood (2010). The task requires participants to identify expressions of the six basic emotions from faces, with ten faces per category. Stimuli are based on the images produced by Ekman and Friesen (1976) and displayed for three seconds at a time. No specific details on reliability or validity information were reported in the articles represented in this review (Spikman et al., 2012; Visser-Keizer et al., 2016; Westerhof-Evers et al., 2017; Williams & Wood, 2010), though the authors point to the tool's manual for this information (Young et al., 2002).

The Emotion Recognition Test (ERT; Rigon, Turkstra, Mutlu, & Duff, 2016) presents participants with neutral faces (male or female) that morph into one of the six core emotions to various degrees of intensity (0-100% in 20% increments). The first part of the computerised test requires participants to select the correct label from a list of emotions, giving a measure of accuracy. However, as an advantage over other tools, the second part of the test asks participants to give an indication from a list of the intensity of emotion, providing a measure of sensitivity. Osborne-Crowley and McDonald (2016) used a subset of the same task, but only employed static images displaying fear, sad, and surprised emotions in order to avoid floor or ceiling effects. The task offers some construct validity; Rigon and colleagues (2016) found correlations between participants' performance on the ERT and the

processing speed index (r = 0.39, p = 0.002) of the Wechsler Adult Intelligence Scale (Holdnack et al., 2011) as well as the somatisation (r = 0.27, p = 0.03) and anxiety subscales (r = 0.26, p = 0.03) of the Brief Symptom Inventory (Derogatis & Melisaratos, 1983).

Social perception: verbal emotion perception.

The assessment of people's interpretation of written and spoken language can be important to social perception as the reader or listeners is engaged in disambiguating meaning or incorporating contextual information for the understanding of an on-going conversation or interaction (Bachorowski, 1999; Liebenthal et al., 2016).

Neumann and colleagues (2012) employed the Emotional Inference from Stories Test (EIST) in their study which the group had developed. The test is presented on the computer with 12 short stories being printed as well as read aloud one at a time. Stories range from 150 to 250 words and require approximately sixth grade (USA) reading level. After the story presentation, participants are asked to assign the story character's dominant emotion as either happy, sad, angry or fearful from a list; they are unable to refer back to the story. The authors were able to demonstrate adequate inter-rater agreement in a validation study with healthy participants (Zupan, 2009) as well as good test-retest reliability (Zupan et al., 2015).

Social perception: humour (sarcasm).

Measures in this category relate to humour, an important ingredient in social relationships. It relies on a variety of social cognitive skills, such as incongruity detection, relief of tension, and understanding of context (Uekermann et al., 2007). Depending on the speaker's intention, sarcasm may be used to criticise the recipient (Filik et al., 2019).

Tasks in this category required participants with TBI to identify sarcastic or ironic versus sincere statements based on their vocal inflection (Davis et al., 2016; Shamay-Tsoory et al., 2005, 2007). In Channon and colleagues (2005; 2010), participants were required to identify sarcastic versus earnest statements at the end of short social stories. Those with TBI demonstrated greater difficulty on sarcastic items compared to healthy control participants, though not on control stories of a separate measure using physical control events. Channon and colleagues (2005) had validated their sarcasm comprehension task in a separate sample of healthy control participants. They reported good inter-rater reliability and internal consistency in a later study (Channon & Crawford, 2010).

Affective empathy.

Empathy, in brief, has been defined as knowing what someone else is feeling, experiencing an emotion that's similar to what they are feeling, and having some intention of reducing the other's suffering (Decety & Jackson, 2004; D. Watt, 2007).

De Sousa and colleagues investigated affective empathy using a self-assessment manikin (SAM) displaying 9 types of emotional reactions in response to emotional videos (De Sousa et al., 2012) or pictures (De Sousa et al., 2010). In both studies, participants with TBI rated pleasant stimuli as significantly less pleasant than control participants and unpleasant stimuli as more pleasant, with no significant difference for neutral stimuli (valence). Meanwhile, participants with TBI rated their arousal as significantly lower compared to health control participants for unpleasant stimuli. The authors report that the measure had demonstrated good reliability in previous research (De Sousa et al., 2012).

Theory of mind.

Theory of mind refers to the cognitive abilities involved in reasoning about and inferring others' emotions, thoughts, and beliefs. It is considered separate from, but closely linked to affective social cognition processes, such as empathy (Preckel et al., 2018).

The Faux Pas Test was employed by a variety of studies (Bivona et al., 2014, 2015; Cohen-Zimerman et al., 2017; Geraci et al., 2010; Kelly et al., 2014; Milders et al., 2003, 2006, 2008; Muller et al., 2010; Shamay-Tsoory et al., 2003, 2005; Spikman et al., 2012; Ubukata et al., 2014; Xi et al., 2011). A faux pas is a social transgression that is not clearly defined, or as Baron-Cohen and colleagues (1999) wrote, "socially normal individuals can usually recognize when someone has committed a faux pas, though specifying the necessary and sufficient criteria for this is difficult" (p. 408). The Faux Pas Test consists of 10 stories with one faux pas each, followed by four questions which attempt to elicit whether (1) the faux pas was recognised, (2) the participant can pinpoint the respective sentence in the story, (3) the story was generally understood and paid attention to as well as (4) the intention is being attributed to a false belief rather than a malicious intent on behalf of the respective character. Some studies also include control stories which do not include a faux pas (Bivona et al., 2014, 2015; Cohen-Zimerman et al., 2017; Milders et al., 2006; Muller et al., 2010). Findings regarding the performance of participants with TBI on the Faux Pas Test were quite consistent between studies; their rate of correct responses on stories containing a faux pas was significantly poorer compared to healthy controls, as reported by Bivona and colleagues (2015) and Muller and colleagues (2010), while correct response rates on control stories were not significantly different. Milders and colleagues (2006) did not find a significant difference in faux pas detection between participants with and without TBI, though participants with TBI performed more poorly on clarifying the part of the story which referred

to the faux pas as well as on rejection of non-faux pas, indicating that the type of question following faux pas which is analysed may be of importance. Bivona and colleagues (2014) found that people with impaired self-awareness and TBI performed significantly worse on the Faux Pas Test compared to participants with adequate self-awareness and healthy controls, suggesting that self-awareness could be a relevant cognitive component in faux pas detection. Cohen-Zimerman and colleagues (2017) and Geraci and colleagues (2010) also reported significant performance deficits in people with TBI on the Faux Pas Test. In the former, however, only in those with left dorsolateral prefrontal cortex compared to right dorsolateral prefrontal cortex or posterior cortex lesions performed significantly worse (Cohen-Zimerman et al., 2017). In the latter, those with ventromedial prefrontal cortex performed significantly worse compared to those with dorsolateral prefrontal cortex lesions and healthy controls (Geraci et al., 2010). As such, the studies offered conflicting results on the possible neurological basis of faux-pas detection. Milders and colleagues (2006) report that the Faux Pas Test offers high inter-rater reliability.

One of the earliest tools for assessing theory of mind are false belief tasks; a variety of unnamed measures exist (Bach, Colvin, Wijeratne, Happe, & Howard, 1998; Baron-Cohen, Leslie, & Frith, 1985; Frith & Corcoran, 1996; Rowe, Bullock, Polkey, & Morris, 2001 as cited in Muller et al., 2010; Shamay-Tsoory & Aharon-Peretz, 2007). False belief tasks are divided into first-order and second-order tasks: first-order tasks assess a person's understanding about a character's perspective on the world while second-order tasks assess a person's understanding of one character's beliefs about another character's mind (Muller et al., 2010). The task is presented in the form of written scenarios to which participants are asked to answer questions. One kind of false belief task is the Cartoon Task (Milders et al., 2006, 2008; Spikman et al., 2012) which presents false beliefs in pictorial format and compares participants' theory of mind interpretations to those of physical scenarios (Happé, Brownell, & Winner, 1999 as cited in Milders et al., 2006). Good inter-rater reliability has been reported for this measure (Milders et al., 2006).

Shamay-Tsoory and colleagues (Shamay-Tsoory et al., 2007; Shamay-Tsoory & Aharon-Peretz, 2007) developed the Yoni measure to assess empathy after TBI. The task presents the basic drawing of a face, called Yoni, with four target stimuli presented in either corner of a computer screen. Yoni's emotional facial expression, eye gaze or physical proximity to other stimuli can be altered, thereby allowing investigation of the participants' understanding of affective, cognitive, and physical parameters, respectively. In the core task, Yoni was always presented in the centre of the screen and participants were to follow written instructions which made it appear as though Yoni was gloating over, envious of or identifying with the picture of a person's facial expression. The emotional facial expressions in each of the four corners were different, and participants had to select the corresponding one using

the computer's mouse. For gloating, Yoni's positive expression had to be matched with a negative expression (incongruent); for envy, Yoni's negative expression had to be matched with a positive one (incongruent); for identification, Yoni's expression had to be matched to the same kind in the facial photograph (congruent). Performance on the task differed significantly in the envy condition between participants with ventromedial or both ventromedial and dorsolateral lesions and healthy control participants. Performance also differed significantly in the gloat condition between participants with ventromedial or inferior frontal lesions compared to healthy control participants. The authors report an initial validation study and good inter-rater reliability (Shamay-Tsoory et al., 2007).

Social behaviour: communication skills.

Language and communication skills are essential for reciprocation, the exchange of social ideas, and maintenance of interpersonal relationships (Bzdok et al., 2016). It has been argued that certain features of language are unique to humans beyond other animal species (Fitch et al., 2010; Seyfarth & Cheney, 2014).

Togher and colleagues (1997) have investigated communicative strategies in TBI using the Generic Structure Potential (GSP). It is a form of qualitative analysis that examines everyday interactions in terms of so-called genres (e.g. appointment-making, interviews); the type of genre is determined by its activity and participants. Each genre is assumed to have certain core elements (e.g. for a telephone enquiry: greeting – service request – service enquiry – service compliance – close – goodbye). Use of elements differed significantly between participants with and without TBI, in that participants with TBI would use more frequent repetition of elements as well as inappropriate or incomplete ones, regardless of whether conversation partners were familiar or unfamiliar (Kilov et al., 2009; Togher et al., 1997; Togher & Hand, 1999). GSP offers excellent inter-rater reliability; validity analyses were not reported to produce rich data which may be one reason why study samples tended to be small (n = 5-10). Additionally, some initial success has been reported in using the GSP for assessing communication improvement when training conversation partners (Togher et al., 2004).

Angeleri and colleagues (2008) have developed the Assessment Battery of Communication (ABaCo). It consists of five scales: linguistic, extra-linguistic, para-linguistic, context, and conversational, each with comprehension and production sections. Broadly speaking, the linguistic scale assesses basic communication acts (e.g. assertions, questions), the extra-linguistic scale assesses gesture comprehension and production, the para-linguistic scale assesses basic emotion perception (e.g. angry or sad prosody), the context scale assesses understanding of social norms through appropriateness of communication, and the conversational scale assesses topic adherence as well as turn-

taking. The scale is made up of 72 examiner prompts and 108 video clips, each with 7 ± 2 spoken words. The ABaCo is reported to correlate with measures of executive function and theory of mind (Bosco et al., 2017) and offer good internal consistency, high inter-rater reliability, as well as good construct validity (Sacco et al., 2008).

Social behaviour: emotional decision-making.

Emotional decision-making requires the integration of different types of information and this may be disrupted following TBI (Naqvi et al., 2006). None of the tasks in this category offered appropriate validity or reliability, so only the most common tool is described as an illustration.

Kelly and colleagues' (Kelly et al., 2013, 2014; Kelly, McDonald, & Rushby, 2017) Cyberball questionnaire is based on the Cyberball computer game. Participants are invited to play a virtual ball tossing game with the instruction that the three other characters in the game represent human players connected via the internet, when in fact the characters' reactions are pre-programmed to represent either inclusion (more ball returns to the player) or exclusion (fewer ball returns to the player). The questionnaire assesses sense of belonging, control, meaningful existence, and self-esteem (also referred to in the articles as fundamental needs), mood, and awareness of deception. The questionnaire is reported to have good concurrent validity with self-report, physiological, and neuroimaging measures (Kelly, McDonald, & Rushby, 2017).

Social behaviour: social skills.

Measurement tools in this category are concerned with the assessment of participants' ability to interact in an appropriate manner in social situations. Social skills require the integration of cognitive, self-perceptive, verbal and non-verbal communicative as well as person-related (e.g. hygiene and grooming) components (Ylvisaker et al., 1992), making this a rather more abstract category than some of the others in this review. None of the tools in this category were used in more than one study, so four measures are presented for illustrative purposes.

The Evaluation of Social Interaction (ESI) measure represents the only tool from an occupational therapy context in this review (Simmons & Griswold, 2010). Participants are observed by an occupational therapist in two social interactions of the participant's choosing and rated on a 27-item, four-point scale, criterion-referenced measure representing a variety of social skills. Examples include information gathering, information sharing, decision-making/problem-solving, collaboration/co-production, acquiring services or goods, and social conversation/small talk. Competency on the scale is achieved by demonstrable behaviour which indicates consistent politeness, respectfulness, timeliness, and social

appropriateness. The ESI was the only measure in this category to offer both suitable validity and reliability (Simmons & Griswold, 2010).

Channon and Crawford (2010) developed the Social Problem Resolution Task which requires participants to develop solutions to ten everyday awkward scenarios based on examples presented as text. Solutions are rated for practical effectiveness as well as social sensitivity. The Social Problem Fluency Task presents participants with ten common social problems and asks to rate them for awkwardness as well as to develop practical solutions. Subsequently, participants are offered to choose from a list of possible response scenarios, meaning they can demonstrate their decision-making competency while removing the requirement for generating answers. Both tasks were shown to have good internal consistency and inter-rater reliability (Channon & Crawford, 2010).

Robertson and Knight (2008) have developed the Social Problem-Solving Test. It presents participants video vignettes which contain seven social problems. In the first section of the test, participants are required to answer questions about the problems, whereas they are asked to role-play solutions for the problems in the second section. Participants' responses are video-recorded for subsequent evaluation. To assess the concurrent validity of the Social-Problem Solving Test, it was correlated with six other measures of social cognition and problem-solving. For participants' social performance, the Social Problem-Solving Test was significantly and positively correlated with the Verbal Reasoning/Judgement test, Alternate Uses Test, and Modified Six Elements as test as well as significantly and negatively correlated with the Request Production Task and Everyday Problem-Solving task. It was not correlated with the New Tower of London task, a measure of abstract reasoning (R. H. Robertson & Knight, 2008).

Discussion

Summary of Findings

This research set out to systemically review the literature for behavioural assessment tools of social cognition for adults after acquired brain injury. The focus was on the tools' validity and reliability. Several useful and important assessment tools have been highlighted.

For social perception, the Diagnostic Assessment of Nonverbal Affect 2 (DANVA-2; Nowicki Jr. & Duke, 1994), Florida Affect Battery-Revised (Bowers et al., 1989, 1998), Facial Expressions of Emotion-Stimuli and Tests (FEEST; Young et al., 2002) and Emotional Inference from Stories Test (EIST; Neumann et al., 2012) offered good validity and reliability across a number of studies. The "Reading the Mind in the Eyes" test (2001; Baron-Cohen et

al., 1997) was also used across a number of studies, and is reported to offer suitable discriminant validity (McDonald et al., 2014). In terms of affective empathy, initial promising results with regards to validity and reliability are available for the self-assessment manikin (SAM; De Sousa et al., 2012, 2010). For theory of mind, the Faux Pas Test (Baron-Cohen et al., 1999) was distinct in terms of reported reliability and validity, but also in its ability to distinguish between groups of participants with and without TBI. The Cartoon Test (Milders et al., 2006, 2008; Spikman et al., 2012) and the Yoni task (Shamay-Tsoory et al., 2007; Shamay-Tsoory & Aharon-Peretz, 2007) offer appropriate inter-rater reliability. Lastly, with respect to social behaviour, initial promising results for reliability and validity are available for the Assessment Battery of Communication (ABaCo; Angeleri et al., 2008) and Cyberball questionnaire (Kelly et al., 2013; Kelly, McDonald, & Rushby, 2017). Based on early findings, the Generic Structure Potential measure (GSP; Togher et al., 1997) may be useful for qualitative analyses with small samples and the Evaluation of Social Interaction (ESI; Simmons & Griswold, 2010) for adoption by occupational practitioners.

Out of 78 assessment tools in total, validity was reported for 19 measures (24.4%) and reliability for 28 measures (35.9%). Twelve tools (15.4%) had reports of both validity and reliability measurements; five tools (6.4%) had more than one kind of validity or reliability reported. The included studies achieved an overall respectable quality rating (0.91 out of 1.00). The inter-rater agreement for a subset of the quality assessment was good (82.1%).

Limitations in social cognition research reports.

A somewhat surprising finding of this review was that no reliability or validity data was reported for the widespread use of the Ekman sets of faces in facial emotion perception research (e.g. Callahan et al., 2011). Of course, this does not mean conclusively that such data does not exist. One of the reasons for this finding could be related to the way in which Ekman sets of faces are considered stimuli, but not discreet tasks. Also striking was the lack of reported validity or reliability data for well-known social cognition tasks, such as the Strange Stories and Sally and Ann (Bosco et al., 2017; Gabbatore et al., 2015) tasks as well as the Iowa Gambling Tasks (Xi et al., 2011) among the sampled studies. A number of tasks have shown promise, such as the Florida Affect Battery (Bowers et al., 1989, 1998), the Emotion Recognition Test (Rigon et al., 2016) as well as the Social Problem-Resolution Task (Channon & Crawford, 2010) and Social Problem-Solving Test (R. H. Robertson & Knight, 2008). However, it appears that there are important gaps to be closed in the literature regarding their reported reliability and validity information. On the reverse, there are good reliability and validity reported for measures of sarcasm or humour, but very few of them appear to exist (e.g. Channon et al., 2005; Channon & Crawford, 2010).

Related reviews.

The following reviews are helpful to consider in conjunction with the present one: interventions for social cognition following brain injury (Driscoll et al., 2010), the impact of social involvement on neuroplasticity (Davidson & McEwen, 2012), and functional brain imaging studies, such as using fMRI (Molenberghs et al., 2016; Xiao et al., 2017). Findings from fMRI research, however, tend to be difficult to compare with purely behavioural tasks, due to differing testing environments (Hughes et al., 2004; Koch et al., 2003).

Since work on this review was started, a similar review has been published entitled "Social communication following traumatic brain injury part I: State-of-the-art review of assessment tools" (Sohlberg et al., 2019). A companion review was concerned with identifying effective components in social communication treatment (Meulenbroek et al., 2019). The former review examined assessment tools' validity and reliability, like the present review. The review by Sohlberg and colleagues (2019) has several further strengths: it evaluated each measure as to whether norms have been published for it, whether it is available for purchase or publicly available, and it examined measures in terms of feasibility, ecological grounding and whether participants stated priorities are taken into account. The present review offers a slightly extended scope, having focussed on social cognition as opposed to the more specific area of social communication, identified somewhat more measures, recorded numerical values for validity or reliability, and examined the methodological quality of included studies.

Limitations of the Review

The following limitations are important to consider when interpreting the findings of this systematic review.

Reliability and validity.

In this review, assessment tools were identified in the four core areas set out by Henry and colleagues (2016): social perception, theory of mind, affective empathy, and social cognition. However, fewer measures were identified for affective empathy and the perception of humour than for theory of mind and social behaviour. In addition, although tools for the assessment of emotional decision-making were found, none reported reliability or validity. These will be useful areas for further development of assessments. In addition, it will be worth repeating this review periodically, as the area of social cognition assessment in people with brain injury, traumatic or otherwise, is expanding (Evers et al., 2019).

Validity and reliability are important means to quantify whether an assessment tool measures what it is intended to measure and whether it does so consistently across time

and contexts (Karras, 1997b, 1997a). Most articles citing the assessment tools identified in this review did not report on their reliability or validity. However, it is important for the reader to note that information about assessment tools' reliability, validity or normative data may have been captured in studies outside of the review's inclusion criteria, such as in healthy populations or those with other kinds of brain injury or in intervention studies. Therefore, this review cannot conclude the definitive absence of validity or reliability information for the identified social cognition measures, only that they were not explicitly stated in the included studies. Future research may highlight such values through snowball searches, meaning references identified from articles bibliographies, or grey literature exploration, such as by contacting researcher about unpublished work (Mahood et al., 2014), and additional studies focussing specifically on psychometric properties.

Generalisability of social cognition assessments.

Relating to the issue of validity, assessment tools in social cognition aim to orient themselves alongside participants' lived experience (Casaletto & Heaton, 2017). However, they may still be subject to contextual factors like other assessment tools (Chaytor & Schmitter-Edgecombe, 2003), such as test environment (e.g. a significant other being in the room) and the amount of feedback (e.g. being given information that responses are incomplete or incorrect). Such elements could not be explored as part of this review, as they were not systematically recorded. In future, further information on assessment tools' acceptability (Ayala & Elder, 2011) and translatability across contexts (Wilson, 1993) will also be valuable.

Quality assessment.

There were three primary concerns to consider in terms of the process of the quality assessment. Although the inter-rater agreement was good, only a subset of studies (12.3%) was co-rated. Even though the number of studies was based on university recommendations and articles were selected randomly for co-rating, a small possibility remains that the quality of ratings may not have been consistent throughout. Secondly, the quality of studies was the only element of the research to be cross-examined. An external check of the search strategy, despite elements of due diligence being applied, may have contributed alternative search terms, refined search criteria or other search portals for consideration. Thirdly, a validation of the data extraction procedure was also absent. Future reviews may offer a confidence or reliability assessment regarding how comprehensively task descriptions, their validity and reliability were collected.

A few difficulties were identified in the use of the quality tool throughout the completion of the ratings. Firstly, the measure was developed with the intention of permitting

the evaluation of quantitative and qualitative studies beyond randomised controlled trials, according to the accompanying manual (Kmet et al., 2004). However, a number of items focussed on randomisation and blinding. In this review, much of the research investigated how individuals affected by TBI performed on a variety of measures compared to individuals without TBI. While of course the items in question could be rated as "not applicable," their contribution to establishing the quality of the included experimental studies was ultimately limited. Secondly, instructions given for scoring were usually quite generous or non-descript, leading to a ceiling effect. This meant there was room for interpretation in the rater's scoring and unless a core section of a study (e.g. justification, description of design, details of analyses, and reasonable interpretation) was positively absent, it was not possible to give a '0' score in line with the tool's instructions. Thirdly and lastly, the tool was missing some core aspects to aid in the replicability of future studies and reviews, such as evaluating the reporting of effect sizes or guidance for appropriate power figures or sample sizes (Asendorpf et al., 2013). As an alternative way of assessing quality, the Cochrane Collaboration tool was considered (Higgins et al., 2011) which permits different ratings of risk whether a particular systematic bias or confounder could be present. However, the Cochrane Collaboration tool also integrates blinding ratings and has not yet been evaluated in terms of reliability, suggesting that a quality scale focussing on measure development may be developed for subsequent systematic reviews with a similar focus.

Directions for Future Research

Social cognition and personality are closely related, yet distinct concepts (Robinson & Gordon, 2011; Santoro & Spiers, 1994; Shany-Ur & Rankin, 2011). Personality can perhaps be considered a more long-term variant of social cognition and theory of mind – it encompasses patterns of motivational and emotional responses which develop over the course of life (Rieger, 2015). Personality could perhaps be considered a fruitful area of future research under a wider umbrella of social cognition impairments in traumatic brain injury.

Personality.

Personality patterns are often influenced by childhood experiences, may not always be completely accessible to conscious awareness, and can be disrupted by TBI either temporarily or permanently (Prigatano, 1992). Only one relevant measures was identified in this review – the Brief Smell Identification Test (Doty et al., 1996). It requires the participant to smell and identify 12 different samples of common odours and performance is thought to be impaired following ventral prefrontal lesions (Fujiwara et al., 2008). In the presented study, a regression analysis determined that the BSIT contributed to explaining changes in

interpersonal relationships alongside the occurrence of post-traumatic amnesia, time since the TBI, and chronological age. Additionally, the measure offers adequate sensitivity, specificity, and test-retest reliability (Weddell & Wood, 2018).

Implications for Clinical Practice

Prior to deploying social cognition measures in clinical practice, it will be important to consider the following contextual factors.

Neuropsychological assessment of social cognition.

The goals of neuropsychological assessment encompass (a) characterising neurological changes and guiding differential diagnoses, (b) detecting alterations in cognitive weaknesses and strengths over time, and (c) informing recommendations for adjustments to facilitate everyday living or rehabilitation planning (Casaletto & Heaton, 2017). In addition, neuropsychological assessments can assist in predicting functional outcomes and are mostly well-received by the persons being assessed (S. Watt & Crowe, 2018). Social cognition is an important component of an accurate and comprehensive formulation and it is hoped that the assessment tools identified here provide adequate material. Meanwhile, what may on occasion hamper their application is a scarcity of normative data, meaning it can be hard to tell how 'abnormal' a client's score is from a comparison or healthy population (Casaletto & Heaton, 2017; Powell, 2008).

Based on the review, there are a number of tools that appear robust for the assessment of social cognition, in terms of reliability, validity, and often wide-spread use. They map on the areas proposed by Henry and colleagues (2016) and may give an overview of a person's social cognition abilities: the Reading the Mind in the Eyes (Baron-Cohen et al., 2001; Baron-Cohen et al., 1997) and Emotional Inferences from Stories (Neumann et al., 2012) tests for social perception, the Self-Assessment Manikin (SAM; De Sousa et al., 2010, 2012) for affective empathy, the Faux Pas Test (Baron-Cohen et al., 1999) for theory of mind, and the Cyberball questionnaire/computer assessment (Kelly et al., 2014) for social skills and decision-making. The review, however, cannot conclude whether these tools in combination offer a more comprehensive, reliable, and valid assessment than comparative batteries, such as the TASIT (McDonald et al., 2003, 2006). To their advantage, the social cognition measures above are freely and widely available, bar the EIST (Neumann et al., 2012).

Limited information exists on the availability of assessment tools for participants following very severe TBI or those in prolonged disorders of consciousness (PDOC; Gill-Thwaites, Elliott, & Munday, 2018; McAleese, Wilson, McEvoy, & Caldwell, 2018). While it is

known that social cognition difficulties can arise after TBI of any severity, people with severe TBI may be noticeably more reliant on others for practical and emotional support (McDonald, 2013). Furthermore, the assessment tools covered in this review often have verbal requirements in terms of written or auditory stimuli and responses, or at least in terms of understanding their instructions. Therefore, caution is required when using the tools detailed above in participants with memory and aphasic difficulties or with global cognitive impairment (Long et al., 2008). It may be worth using e.g. static faces as opposed to moving ones (e.g. RMET; Baron-Cohen et al., 2001) or different response formats which rely less on verbal report (e.g. FAB; Bowers et al., 1989, 1998) in order to accommodate a person's idiosyncratic level of functioning.

Co-occurring conditions.

Difficulties with social cognition are known to exist in neurodevelopmental or psychiatric conditions, such as autism spectrum disorder and schizophrenia (Derntl & Habel, 2011; Martins Jr. et al., 2011). Some psychiatric difficulties may commonly present themselves as a result of traumatic brain injury, such as depression, anxiety or problems with sleep (Newburn, 1998; Schwarzbold et al., 2008). Assessment tools described in this review were not used separately for those participants with TBI who also met criteria for a psychiatric disorder. However, people with psychiatric conditions may have altered social cognition regardless of the involvement of TBI, so this is an important consideration in clinical practice (Plana et al., 2014; Weightman et al., 2014).

Specificity of social cognition categories.

Henry and colleagues (2016) have argued that appropriate therapeutic decisions in working with adults with TBI requires careful consideration of the origin and specificity of social cognition deficits. Areas for assessment of social cognition were represented as separate in this review in order to provide a reasonable structure. However, social cognition subcategories are best conceptualised as overlapping and interdependent (Lieberman, 2007). For instance, social decision-making and behaviour require the perception of social cues. In daily interactions, these are rarely divided into facial, verbal, and non-verbal perception (Turkstra, 2008). Rather, a variety of social cues are integrated with signals from the body (e.g. affective empathy) and interpretations about the reasons for others' actions (e.g. theory of mind; Adolphs, 2003). Assessment tools for social cognition which use written stories may, for instance, invite participants to visualise a scene or make decisions about texts (Happé, 1994). Occasionally, such processing is automatic and other times slow and more deliberate, though said distinction still requires further investigation in the social cognition context (Lieberman, 2007). Compared to the assessment of cognitive abilities,

there are also often tasks that tap into more than one cognitive ability at once and deficits can be identified through the interplay in outcomes (Canivez & Watkins, 2010). Consequently, Henry and colleagues (2016) suggest that a thorough assessment of social cognition also examine executive, language, and perceptual abilities.

Conclusion

This review set out to systematically investigate the literature on adults with traumatic brain injury to identify assessment tools for social cognition, including the areas of social perception, theory of mind, affective empathy, and social behaviour. The review has contributed an overview of these measures, their previous use in the TBI literature as well as detailed information on assessment tools' validity and reliability. Furthermore, the review set out a quality assessment of the available studies. The list of measures and information regarding their psychometric properties may serve as a useful tool for clinicians in guiding assessment, formulation, treatment, and tracking clients' and participants' progress.

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Appendix 5 – Search Terms

Each search included three elements combined with the Boolean operator 'AND':

- search terms under "keywords" for social cognition ("theory of mind" or "social cognition*" or "social cognitive" or "social inference*" or "socially inferred" or "social perception*" or "socially perceived" or "social behaviour*" or "interpersonal" or "emotion perception*" or "emotionally perceived"),

- search terms under "keywords" for assessment measures ("assess*" or "survey*" or "measure*" or "quest*" or "task*" or "method*"), and

- search terms under "keywords" for various types of brain injury ("brain injur*" or "neuropath*" or "encephal*" or "epilep*" or "brain infarct*" or "cerebral infarct*" or "stroke*" or "aneurysm*" or "haematoma*" or "hematoma*" or "hemorrhage*" or "oedema*" or "edema*" or "concussion*" or "skull fracture*" or "brain cancer*" or "brain tumor*" or "brain tumour*" or "brain neoplasm*" or "ischemia" or "anoxia" or "hypoxia" or "ABI" or "TBI" or "PCS."

Terms for types of brain injury other than traumatic kind were included in case a study was identified in which one group was made up of participants with TBI and one or other groups with different kinds of brain injury.

Appendix 6 – Quality Ratings

Table 6. Behavioural assessment tools for social cognition in people with traumatic brain injury – study quality ratings.

Table 6

*Quality Ratings (Part 1)**

Count	Author(s)	Year	Study	Question / Objective	Study Design	Group Selection	Participant Characteristics	Allocation	Investigator Blinding	Participant Blinding
1	Aboulafia-Brakha, T., Allain, P., and Ptak, R.	2016		3	3	2	3	999	999	3
2	Adlam, A. L. R., Adams, M., Turnbull, O., Yeates, G., and Gracey, F.	2017		3	3	2	3	999	999	999
3	Adolphs, R., Damasio, H., Tranel, D., Cooper, G., and Damasio, A. R.	2000		3	3	2	3	999	3	999
4	Angeleri, R., Bosco, F. M., Zettin, M., Sacco, K., Colle, L., and Bara, B. G.	2008		3	3	2	3	999	3	999
5	Bara, B. G., Tirassa, M., and Zettin, M.	1997		3	3	2	2	999	3	999
6	Bibby, H. and McDonald, S.	2005		3	3	2	3	999	2	999

* 3 = ‘Yes’/Present; 2 = ‘Partial’; 1 = ‘No’/‘Absent’; 999 = Not stated

Table 6 (cont'd)

Quality Ratings (Part 1)

Count	Author(s)	Year	Study	Question / Objective	Study Design	Group Selection	Participant Characteristics	Allocation	Investigator Blinding	Participant Blinding
7	Bivona, U., Formisano, R., De Laurentiis, S., Accetta, N., Rita Di Cosimo, M., Massicci, R., Ciurli, P., Azicnuda, E., Silvestro, D., Sabatini, U., Falletta Caravasso, C., Augusto Carlesimo, G., Caltagirone, C., and Costa, A.	2015		3	3	3	3	999	2	999
8	Bivona, U., Riccio, A., Ciurli, P., Carlesimo, G. A., Donne, V. D., Pizzonia, E., Caltagirone, C., Formisano, R., and Costa, A.	2014		3	3	3	3	999	2	999
9	Bornhofen, C. and McDonald, S.	2008		3	3	2	3	3	1	999
10	Bosco, F. M., Parola, A., Sacco, K., Zettin, M., and Angeleri, R.	2017		3	3	2	3	999	3	999

Table 6 (cont'd)

Quality Ratings (Part 1)

Count	Author(s)	Year	Study	Question / Objective	Study Design	Group Selection	Participant Characteristics	Allocation	Investigator Blinding	Participant Blinding
11	Byom, L. J. and Turkstra, L.	2012		3	3	2	3	999	3	999
12	Callahan, B. L., Ueda, K., Sakata, D., Plamondon, A., and Murai, T.	2011		3	2	3	3	999	999	999
13	Channon, S. and Crawford, S.	2010		3	3	2	3	999	3	999
14	Channon, S., Pellijeff, A., and Rule, A.	2005		2	3	3	3	999	999	999
15	Cohen-Zimerman, S., Chau, A., Krueger, F., Gordon, B., and Grafman, J.	2017		3	3	2	3	999	3	999
16	Croker, V. and McDonald, S.	2005		3	3	3	3	999	2	999
17	Dardier, V., Bernicot, J., Delanoë, A., Vanberten, M., Fayada, C., Chevignard, M., Delaye, C., Laurent-Vannier, A., and Dubois, B.	2011		3	3	2	3	999	1	999

Table 6 (cont'd)

Quality Ratings (Part 1)

Count	Author(s)	Year	Study	Question / Objective	Study Design	Group Selection	Participant Characteristics	Allocation	Investigator Blinding	Participant Blinding
18	De Sousa, A., McDonald, S., and Rushby, J.	2012		3	3	3	3	999	999	3
19	De Sousa, A., McDonald, S., Rushby, J., Li, S., Dimoska, A., and James, C.	2010		3	3	3	3	999	999	999
20	Doi, R., Morita, K., Shigemori, M., Tokutomi, T., and Maeda, H.	2007		3	3	2	3	999	999	999
21	Dresang, H. C. and Turkstra, L. S.	2018		3	3	3	3	999	999	999
22	Ducharme, J. M., Spencer, T., Davidson, A., and Rushford, N.	2002		3	3	3	3	999	3	999
23	Forbes, C. E., Poore, J. C., Barbey, A. K., Krueger, F., Solomon, J., Lipsky, R. H., Hodgkinson, C. A., Goldman, D., and Grafman, J.	2012		3	3	3	3	999	3	999

Table 6 (cont'd)

Quality Ratings (Part 1)

Count	Author(s)	Year	Study	Question / Objective	Study Design	Group Selection	Participant Characteristics	Allocation	Investigator Blinding	Participant Blinding
24	Gabbatore, I., Sacco, K., Angeleri, R., Zettin, M., Bara, B. G., and Bosco, F. M.	2015		3	3	3	3	999	3	999
25	Genova, H. M., Genualdi, A., Goverover, Y., Chiaravalloti, N. D., Marino, C., and Lengenfelder, J.	2017		2	3	2	3	999	999	999
26	Geraci, A., Surian, L., Ferraro, M., and Cantagallo, A.	2010		3	3	2	3	999	999	999
27	Godfrey, H. P. D., Knight, R. G., and Bishara, S. N.	1991		3	3	2	3	999	3	999
28	Green, R. E. A., Turner, G. R., and Thompson, W. F.	2004		3	3	2	3	999	999	999
29	Henry, J. D., Phillips, L. H., Crawford, J. R., Ietswaart, M., and Summers, F.	2006		3	3	2	2	999	999	999

Table 6 (cont'd)

Quality Ratings (Part 1)

Count	Author(s)	Year	Study	Question / Objective	Study Design	Group Selection	Participant Characteristics	Allocation	Investigator Blinding	Participant Blinding
30	Honan, C. A., Allen, S. K., Fisher, A., Osborne-Crowley, K., and McDonald, S.	2017		3	3	3	3	999	1	999
31	Honan, C. A., McDonald, S., Gowland, A., Fisher, A., and Randall, R. K.	2015		3	3	3	3	999	999	999
32	Johnstone, B., Cohen, D., Bryant, K. R., Glass, B., and Christ, S. E.	2015		2	3	999	3	999	999	999
33	Kelly, M., McDonald, S., and Kellett, D.	2014		3	3	3	3	999	999	999
34	Kelly, M., McDonald, S., and Kellett, D.	2013		3	3	3	3	999	999	3
35	Kelly, M., McDonald, S., and Rushby, J.	2017		3	3	3	3	999	999	3
36	Kilov, A. M., Togher, L., and Grant, S.	2009		3	3	2	3	999	3	999
37	Lew, H. L., Poole, J. H., Chiang, J. Y. P., Lee, E. H., Date, E. S., and Warden, D.	2005		3	3	3	1	999	999	999

Table 6 (cont'd)

Quality Ratings (Part 1)

Count	Author(s)	Year	Study	Question / Objective	Study Design	Group Selection	Participant Characteristics	Allocation	Investigator Blinding	Participant Blinding
38	McDonald, S., Gowland, A., Randall, R., Fisher, A., Osborne-Crowley, K., and Honan, C.	2014		3	3	3	3	999	3	999
39	McDonald, S., Li, S., De Sousa, A., Rushby, J., Dimoska, A., James, C., and Tate, R. L.	2011		3	3	3	3	999	999	3
40	McDonald, S., Rosenfeld, J., Henry, J. D., Togher, L., Tate, R., and Bornhofen, C.	2011		3	3	3	3	999	999	999
41	McDonald, S., Rushby, J., Li, S., De Sousa, A., Dimoska, A., James, C., Tate, R., and Togher, L.	2011		3	3	3	3	999	999	999
42	McDonald, S., Saad, A., and James, C.	2011		3	3	2	3	999	999	999
43	McDonald, S., Togher, L., Tate, R., Randall, R., English, T., and Gowland, A.	2013		3	3	3	3	3	3	999

Table 6 (cont'd)

Quality Ratings (Part 1)

Count	Author(s)	Year	Study	Question / Objective	Study Design	Group Selection	Participant Characteristics	Allocation	Investigator Blinding	Participant Blinding
44	Milders, M., Fuchs, S., and Crawford, J. R.	2003		3	3	3	3	999	999	999
45	Milders, M., Ietswaart, M., Crawford, J. R., and Currie, D.	2006		3	3	3	3	999	999	999
46	Milders, M., Ietswaart, M., Crawford, J. R., and Currie, D.	2008		3	3	3	3	999	999	999
47	Muller, F., Simion, A., Reviriego, E., Galera, C., Mazaux, J. M., Barat, M., and Joseph, P. A.	2010		3	3	2	3	999	999	999
48	Neumann, D., Babbage, D. R., Zupan, B., and Willer, B.	2015		3	3	3	3	3	3	999
49	Neumann, D., Malec, J. F., and Hammond, F. M.	2015		3	3	3	3	999	999	999
50	Neumann, D., Zupan, B., Babbage, D. R., Radnovich, A. J., Tomita, M., Hammond, F., and Willer, B.	2012		3	3	3	3	999	999	999

Table 6 (cont'd)

Quality Ratings (Part 1)

Count	Author(s)	Year	Study	Question / Objective	Study Design	Group Selection	Participant Characteristics	Allocation	Investigator Blinding	Participant Blinding
51	Neumann, D., Zupan, B., Malec, J. F., and Hammond, F.	2014		3	2	3	3	999	999	999
52	Osborne-Crowley, K. and McDonald, S.	2016		3	3	3	3	999	3	999
53	Radice-Neumann, D., Zupan, B., Tomita, M., and Willer, B.	2009		3	3	3	3	3	1	999
54	Rigon, A., Turkstra, L., Mutlu, B., and Duff, M.	2016		3	3	3	3	999	999	999
55	Robertson, R. H. and Knight, R. G.	2008		3	3	2	3	999	3	999
56	Santoro, J. and Spiers, M.	1994		2	3	2	3	999	999	999
57	Saxton, M. E., Younan, S. S., and Lah, S.	2013		3	3	2	3	999	999	999
58	Shamay-Tsoory, S. G. and Aharon-Peretz, J.	2007		3	3	2	3	999	3	999
59	Shamay-Tsoory, S. G., Tibi-Elhanany, Y., and Aharon-Peretz, J.	2007		3	3	3	3	999	3	999

Table 6 (cont'd)

Quality Ratings (Part 1)

Count	Author(s)	Year	Study	Question / Objective	Study Design	Group Selection	Participant Characteristics	Allocation	Investigator Blinding	Participant Blinding
60	Shamay-Tsoory, S. G., Tomer, R., and Aharon-Peretz, J.	2005		3	3	3	2	999	3	999
61	Shamay-Tsoory, S. G., Tomer, R., Berger, B. D., and Aharon-Peretz, J.	2003		3	3	3	3	999	3	999
62	Shamay-Tsoory, S. G., Tomer, R., Goldsher, D., Berger, B. D., and Aharon-Peretz, J.	2004		2	3	2	3	999	3	999
63	Shu, I. W., Onton, J. A., Prabhakar, N., O'Connell, R. M., Simmons, A. N., and Matthews, S. C.	2014		3	3	3	3	999	999	999
64	Sim, P., Power, E., and Togher, L.	2013		3	3	3	3	2	3	999
65	Simmons, C. D. and Griswold, L. A.	2010		3	3	3	3	999	3	999

Table 6 (cont'd)

Quality Ratings (Part 1)

Count	Author(s)	Year	Study	Question / Objective	Study Design	Group Selection	Participant Characteristics	Allocation	Investigator Blinding	Participant Blinding
66	Spikman, J. M., Timmerman, M. E., Milders, M. V., Veenstra, W. S., and van der Naalt, J.	2012		3	3	3	3	999	3	999
67	Struchen, M. A., Clark, A. N., Sander, A. M., Mills, M. R., Evans, G., and Kurtz, D.	2008		3	3	3	3	999	999	999
68	Struchen, M. A., Pappadis, M. R., Sander, A. M., Burrows, C. S., and Myszka, K. A.	2011		3	3	3	3	999	999	999
69	Togher, L. and Hand, L.	1999		3	3	3	3	999	2	999
70	Togher, L., Hand, L., and Code, C.	1997		3	3	2	3	999	2	999

Table 6 (cont'd)

Quality Ratings (Part 1)

Count	Author(s)	Year	Study	Question / Objective	Study Design	Group Selection	Participant Characteristics	Allocation	Investigator Blinding	Participant Blinding
71	Turkstra, L. S., Kraning, S. G., Riedeman, S. K., Mutlu, B., Duff, M., and Vandenheuvel, S.	2017	A	3	3	3	2	999	3	999
	Turkstra, L. S., Kraning, S. G., Riedeman, S. K., Mutlu, B., Duff, M., and Vandenheuvel, S.	2017	B	3	3	3	3	999	3	999
72	Turkstra, L. S., Norman, R. S., Mutlu, B., and Duff, M. C.	2018		3	3	2	3	999	999	999
73	Turkstra, L. S., Quinn-Padron, M., Johnson, J. E., Workinger, M. S., and Antoniotti, N.	2012		3	3	3	3	999	3	999
74	Ubukata, S., Tanemura, R., Yoshizumi, M., Sugihara, G., Murai, T., and Ueda, K.	2014		3	3	3	3	999	999	999

Table 6 (cont'd)

Quality Ratings (Part 1)

Count	Author(s)	Year	Study	Question / Objective	Study Design	Group Selection	Participant Characteristics	Allocation	Investigator Blinding	Participant Blinding
75	Visser-Keizer, A. C., Westerhof-Evers, H. J., Gerritsen, M. J. J., van der Naalt, J., and Spikman, J. M.	2016		3	3	3	3	999	999	999
76	Weddell, R. A. and Wood, R. L.	2018		3	3	3	3	999	999	999
77	Westerhof-Evers, H. J., Visser-Keizer, A. C., Fasotti, L., Schönherr, M. C., Vink, M., Van Der Naalt, J., and Spikman, J. M.	2017		3	3	3	3	3	3	3
78	Williams, C. and Wood, R. L.	2010		3	3	3	3	999	999	999
79	Xi, C., Zhu, Y., Niu, C., Zhu, C., Lee, T. M. C., Tian, Y., and Wang, K.	2011		3	3	3	3	999	1	999

Table 6 (cont'd)

Quality Ratings (Part 1)

Count	Author(s)	Year	Study	Question / Objective	Study Design	Group Selection	Participant Characteristics	Allocation	Investigator Blinding	Participant Blinding
80	Zupan, B., Babbage, D., Neumann, D., and Willer, B.	2017		3	3	3	3	999	999	999
81	Zupan, B., Neumann, D., Babbage, D. R., and Willer, B.	2015	A	3	3	1	3	999	999	999
	Zupan, B., Neumann, D., Babbage, D. R., and Willer, B.	2015	B	3	3	3	3	2	999	999

Table 6

*Quality Ratings (Part 2)**

Count	Author(s)	Year	Study	Means of Assessment	Sample Size	Analytic Methods	Estimate of Variance	Control for Confounders	Results Report	Conclusion
1	Aboulafia-Brakha, T., Allain, P., and Ptak, R.	2016		3	2	3	3	2	3	3
2	Adlam, A. L. R., Adams, M., Turnbull, O., Yeates, G., and Gracey, F.	2017		2	2	3	3	3	3	3
3	Adolphs, R., Damasio, H., Tranel, D., Cooper, G., and Damasio, A. R.	2000		3	3	3	3	3	3	3
4	Angeleri, R., Bosco, F. M., Zettin, M., Sacco, K., Colle, L., and Bara, B. G.	2008		3	3	3	3	3	3	3
5	Bara, B. G., Tirassa, M., and Zettin, M.	1997		3	2	3	1	3	3	3
6	Bibby, H. and McDonald, S.	2005		3	3	3	1	3	3	3

* 3 = ‘Yes’/Present; 2 = ‘Partial’; 1 = ‘No’/‘Absent’; 999 = Not stated

Table 6 (cont'd)

Quality Ratings (Part 2)

Count	Author(s)	Year	Study	Means of Assessment	Sample Size	Analytic Methods	Estimate of Variance	Control for Confounders	Results Report	Conclusion
7	Bivona, U., Formisano, R., De Laurentiis, S., Accetta, N., Rita Di Cosimo, M., Massicci, R., Ciurli, P., Azicnuda, E., Silvestro, D., Sabatini, U., Falletta Caravasso, C., Augusto Carlesimo, G., Caltagirone, C., and Costa, A.	2015		3	3	3	3	3	3	3
8	Bivona, U., Riccio, A., Ciurli, P., Carlesimo, G. A., Donne, V. D., Pizzonia, E., Caltagirone, C., Formisano, R., and Costa, A.	2014		3	2	3	3	3	3	3
9	Bornhofen, C. and McDonald, S.	2008		3	2	3	3	3	3	3

Table 6 (cont'd)

Quality Ratings (Part 2)

Count	Author(s)	Year	Study	Means of Assessment	Sample Size	Analytic Methods	Estimate of Variance	Control for Confounders	Results Report	Conclusion
10	Bosco, F. M., Parola, A., Sacco, K., Zettin, M., and Angeleri, R.	2017		3	3	3	3	3	3	3
11	Byom, L. J. and Turkstra, L.	2012		3	2	3	2	3	3	3
12	Callahan, B. L., Ueda, K., Sakata, D., Plamondon, A., and Murai, T.	2011		3	2	3	3	2	3	3
13	Channon, S. and Crawford, S.	2010		3	2	2	3	3	3	3
14	Channon, S., Pellijeff, A., and Rule, A.	2005		2	3	3	3	999	3	3
15	Cohen-Zimerman, S., Chau, A., Krueger, F., Gordon, B., and Grafman, J.	2017		3	3	3	3	3	3	3
16	Croker, V. and McDonald, S.	2005		3	3	3	3	2	3	3

Table 6 (cont'd)

Quality Ratings (Part 2)

Count	Author(s)	Year	Study	Means of Assessment	Sample Size	Analytic Methods	Estimate of Variance	Control for Confounders	Results Report	Conclusion
17	Dardier, V., Bernicot, J., Delanoë, A., Vanberten, M., Fayada, C., Chevignard, M., Delaye, C., Laurent-Vannier, A., and Dubois, B.	2011		3	2	3	999	999	3	3
18	De Sousa, A., McDonald, S., and Rushby, J.	2012		3	2	3	3	3	3	3
19	De Sousa, A., McDonald, S., Rushby, J., Li, S., Dimoska, A., and James, C.	2010		3	3	3	3	3	3	3
20	Doi, R., Morita, K., Shigemori, M., Tokutomi, T., and Maeda, H.	2007		3	3	3	3	3	3	3
21	Dresang, H. C. and Turkstra, L. S.	2018		3	2	3	3	3	3	3

Table 6 (cont'd)

Quality Ratings (Part 2)

Count	Author(s)	Year	Study	Means of Assessment	Sample Size	Analytic Methods	Estimate of Variance	Control for Confounders	Results Report	Conclusion
22	Ducharme, J. M., Spencer, T., Davidson, A., and Rushford, N.	2002		3	3	3	2	999	3	3
23	Forbes, C. E., Poore, J. C., Barbey, A. K., Krueger, F., Solomon, J., Lipsky, R. H., Hodgkinson, C. A., Goldman, D., and Grafman, J.	2012		3	2	3	3	3	3	3
24	Gabbatore, I., Sacco, K., Angeleri, R., Zettin, M., Bara, B. G., and Bosco, F. M.	2015		3	2	3	1	3	3	3
25	Genova, H. M., Genualdi, A., Goverover, Y., Chiaravalloti, N. D., Marino, C., and Lengenfelder, J.	2017		3	3	3	3	2	3	3
26	Geraci, A., Surian, L., Ferraro, M., and Cantagallo, A.	2010		3	3	2	3	3	3	3

Table 6 (cont'd)

Quality Ratings (Part 2)

Count	Author(s)	Year	Study	Means of Assessment	Sample Size	Analytic Methods	Estimate of Variance	Control for Confounders	Results Report	Conclusion
27	Godfrey, H. P. D., Knight, R. G., and Bishara, S. N.	1991		2	2	3	3	999	3	3
28	Green, R. E. A., Turner, G. R., and Thompson, W. F.	2004		3	3	3	3	3	3	3
29	Henry, J. D., Phillips, L. H., Crawford, J. R., Ietswaart, M., and Summers, F.	2006		3	2	3	3	3	3	3
30	Honan, C. A., Allen, S. K., Fisher, A., Osborne-Crowley, K., and McDonald, S.	2017		3	3	3	3	2	3	3
31	Honan, C. A., McDonald, S., Gowland, A., Fisher, A., and Randall, R. K.	2015		3	3	3	3	2	3	3
32	Johnstone, B., Cohen, D., Bryant, K. R., Glass, B., and Christ, S. E.	2015		3	2	3	3	3	2	3
33	Kelly, M., McDonald, S., and Kellett, D.	2014		3	3	3	2	2	3	3

Table 6 (cont'd)

Quality Ratings (Part 2)

Count	Author(s)	Year	Study	Means of Assessment	Sample Size	Analytic Methods	Estimate of Variance	Control for Confounders	Results Report	Conclusion
34	Kelly, M., McDonald, S., and Kellett, D.	2013		3	3	3	3	3	3	3
35	Kelly, M., McDonald, S., and Rushby, J.	2017		3	2	3	3	3	3	3
36	Kilov, A. M., Togher, L., and Grant, S.	2009		3	2	3	2	2	3	3
37	Lew, H. L., Poole, J. H., Chiang, J. Y. P., Lee, E. H., Date, E. S., and Warden, D.	2005		3	2	3	3	2	3	3
38	McDonald, S., Gowland, A., Randall, R., Fisher, A., Osborne-Crowley, K., and Honan, C.	2014		2	3	3	3	2	3	3
39	McDonald, S., Li, S., De Sousa, A., Rushby, J., Dimoska, A., James, C., and Tate, R. L.	2011		3	2	3	3	3	3	3

Table 6 (cont'd)

Quality Ratings (Part 2)

Count	Author(s)	Year	Study	Means of Assessment	Sample Size	Analytic Methods	Estimate of Variance	Control for Confounders	Results Report	Conclusion
40	McDonald, S., Rosenfeld, J., Henry, J. D., Togher, L., Tate, R., and Bornhofen, C.	2011		3	3	3	3	3	3	3
41	McDonald, S., Rushby, J., Li, S., De Sousa, A., Dimoska, A., James, C., Tate, R., and Togher, L.	2011		3	2	3	3	3	3	3
42	McDonald, S., Saad, A., and James, C.	2011		3	3	3	3	2	3	3
43	McDonald, S., Togher, L., Tate, R., Randall, R., English, T., and Gowland, A.	2013		3	2	3	3	2	3	3
44	Milders, M., Fuchs, S., and Crawford, J. R.	2003		3	2	3	3	3	3	3
45	Milders, M., Ietswaart, M., Crawford, J. R., and Currie, D.	2006		3	3	2	3	2	3	3

Table 6 (cont'd)

Quality Ratings (Part 2)

Count	Author(s)	Year	Study	Means of Assessment	Sample Size	Analytic Methods	Estimate of Variance	Control for Confounders	Results Report	Conclusion
46	Milders, M., Ietswaart, M., Crawford, J. R., and Currie, D.	2008		3	2	3	3	3	3	3
47	Muller, F., Simion, A., Reviriego, E., Galera, C., Mazaux, J. M., Barat, M., and Joseph, P. A.	2010		3	2	3	3	3	3	3
48	Neumann, D., Babbage, D. R., Zupan, B., and Willer, B.	2015		3	3	3	3	2	3	3
49	Neumann, D., Malec, J. F., and Hammond, F. M.	2015		3	3	3	3	999	3	3
50	Neumann, D., Zupan, B., Babbage, D. R., Radnovich, A. J., Tomita, M., Hammond, F., and Willer, B.	2012		3	3	3	3	3	3	3

Table 6 (cont'd)

Quality Ratings (Part 2)

Count	Author(s)	Year	Study	Means of Assessment	Sample Size	Analytic Methods	Estimate of Variance	Control for Confounders	Results Report	Conclusion
51	Neumann, D., Zupan, B., Malec, J. F., and Hammond, F.	2014		3	2	3	3	2	3	3
52	Osborne-Crowley, K. and McDonald, S.	2016		3	2	3	3	3	3	3
53	Radice-Neumann, D., Zupan, B., Tomita, M., and Willer, B.	2009		3	2	3	3	2	3	3
54	Rigon, A., Turkstra, L., Mutlu, B., and Duff, M.	2016		3	3	3	3	3	3	3
55	Robertson, R. H. and Knight, R. G.	2008		3	3	3	3	3	3	3
56	Santoro, J. and Spiers, M.	1994		2	3	3	1	3	3	3
57	Saxton, M. E., Younan, S. S., and Lah, S.	2013		3	2	3	3	1	3	3
58	Shamay-Tsoory, S. G. and Aharon-Peretz, J.	2007		3	3	2	3	3	3	3

Table 6 (cont'd)

Quality Ratings (Part 2)

Count	Author(s)	Year	Study	Means of Assessment	Sample Size	Analytic Methods	Estimate of Variance	Control for Confounders	Results Report	Conclusion
59	Shamay-Tsoory, S. G., Tibi-Elhanany, Y., and Aharon-Peretz, J.	2007		3	2	2	3	3	3	3
60	Shamay-Tsoory, S. G., Tomer, R., and Aharon-Peretz, J.	2005		3	2	3	3	1	3	3
61	Shamay-Tsoory, S. G., Tomer, R., Berger, B. D., and Aharon-Peretz, J.	2003		3	3	2	2	2	3	3
62	Shamay-Tsoory, S. G., Tomer, R., Goldsher, D., Berger, B. D., and Aharon-Peretz, J.	2004		3	2	2	3	2	3	3
63	Shu, I. W., Onton, J. A., Prabhakar, N., O'Connell, R. M., Simmons, A. N., and Matthews, S. C.	2014		3	3	2	2	3	3	3
64	Sim, P., Power, E., and Togher, L.	2013		3	2	3	3	3	3	3

Table 6 (cont'd)

Quality Ratings (Part 2)

Count	Author(s)	Year	Study	Means of Assessment	Sample Size	Analytic Methods	Estimate of Variance	Control for Confounders	Results Report	Conclusion
65	Simmons, C. D. and Griswold, L. A.	2010		3	3	3	3	999	3	3
66	Spikman, J. M., Timmerman, M. E., Milders, M. V., Veenstra, W. S., and van der Naalt, J.	2012		3	2	3	3	2	3	3
67	Struchen, M. A., Clark, A. N., Sander, A. M., Mills, M. R., Evans, G., and Kurtz, D.	2008		3	3	3	3	999	3	3
68	Struchen, M. A., Pappadis, M. R., Sander, A. M., Burrows, C. S., and Myszka, K. A.	2011		3	3	3	3	999	3	3
69	Togher, L. and Hand, L.	1999		3	2	3	999	2	3	2
70	Togher, L., Hand, L., and Code, C.	1997		3	2	3	999	2	3	3

Table 6 (cont'd)

Quality Ratings (Part 2)

Count	Author(s)	Year	Study	Means of Assessment	Sample Size	Analytic Methods	Estimate of Variance	Control for Confounders	Results Report	Conclusion
71	Turkstra, L. S., Kraning, S. G., Riedeman, S. K., Mutlu, B., Duff, M., and Vandenheuvel, S.	2017	A	3	3	3	999	2	3	3
	Turkstra, L. S., Kraning, S. G., Riedeman, S. K., Mutlu, B., Duff, M., and Vandenheuvel, S.	2017	B	3	1	3	999	2	3	3
72	Turkstra, L. S., Norman, R. S., Mutlu, B., and Duff, M. C.	2018		3	3	3	3	3	3	3
73	Turkstra, L. S., Quinn-Padron, M., Johnson, J. E., Workinger, M. S., and Antoniotti, N.	2012		3	2	3	3	999	3	3

Table 6 (cont'd)

Quality Ratings (Part 2)

Count	Author(s)	Year	Study	Means of Assessment	Sample Size	Analytic Methods	Estimate of Variance	Control for Confounders	Results Report	Conclusion
74	Ubukata, S., Tanemura, R., Yoshizumi, M., Sugihara, G., Murai, T., and Ueda, K.	2014		2	2	3	3	999	3	3
75	Visser-Keizer, A. C., Westerhof-Evers, H. J., Gerritsen, M. J. J., van der Naalt, J., and Spikman, J. M.	2016		3	3	3	3	3	3	3
76	Weddell, R. A. and Wood, R. L.	2018		3	3	3	3	999	3	3
77	Westerhof-Evers, H. J., Visser-Keizer, A. C., Fasotti, L., Schönherr, M. C., Vink, M., Van Der Naalt, J., and Spikman, J. M.	2017		2	2	3	3	3	3	3
78	Williams, C. and Wood, R. L.	2010		3	3	3	3	3	3	3

Table 6 (cont'd)

Quality Ratings (Part 2)

Count	Author(s)	Year	Study	Means of Assessment	Sample Size	Analytic Methods	Estimate of Variance	Control for Confounders	Results Report	Conclusion
79	Xi, C., Zhu, Y., Niu, C., Zhu, C., Lee, T. M. C., Tian, Y., and Wang, K.	2011		2	3	3	3	3	3	3
80	Zupan, B., Babbage, D., Neumann, D., and Willer, B.	2017		3	3	3	2	3	3	3
81	Zupan, B., Neumann, D., Babbage, D. R., and Willer, B.	2015	A	3	3	3	3	999	3	3
	Zupan, B., Neumann, D., Babbage, D. R., and Willer, B.	2015	B	3	3	3	3	2	3	3

Table 6 (cont'd)

*Quality Ratings (Part 3)**

Count	Author(s)	Year	Study	Summary Score
1	Aboulafia-Brakha, T., Allain, P., and Ptak, R.	2016		0.88
2	Adlam, A. L. R., Adams, M., Turnbull, O., Yeates, G., and Gracey, F.	2017		0.86
3	Adolphs, R., Damasio, H., Tranel, D., Cooper, G., and Damasio, A. R.	2000		0.96
4	Angeleri, R., Bosco, F. M., Zettin, M., Sacco, K., Colle, L., and Bara, B. G.	2008		0.96
5	Bara, B. G., Tirassa, M., and Zettin, M.	1997		0.79
6	Bibby, H. and McDonald, S.	2005		0.83
7	Bivona, U., Formisano, R., De Laurentiis, S., Accetta, N., Rita Di Cosimo, M., Massicci, R., Ciurli, P., Azicnuda, E., Silvestro, D., Sabatini, U., Falletta Caravasso, C., Augusto Carlesimo, G., Caltagirone, C., and Costa, A.	2015		0.96
8	Bivona, U., Riccio, A., Ciurli, P., Carlesimo, G. A., Donne, V. D., Pizzonia, E., Caltagirone, C., Formisano, R., and Costa, A.	2014		0.92
9	Bornhofen, C. and McDonald, S.	2008		0.85
10	Bosco, F. M., Parola, A., Sacco, K., Zettin, M., and Angeleri, R.	2017		0.96
11	Byom, L. J. and Turkstra, L.	2012		0.88
12	Callahan, B. L., Ueda, K., Sakata, D., Plamondon, A., and Murai, T.	2011		0.86
13	Channon, S. and Crawford, S.	2010		0.88
14	Channon, S., Pellijeff, A., and Rule, A.	2005		0.90
15	Cohen-Zimerman, S., Chau, A., Krueger, F., Gordon, B., and Grafman, J.	2017		0.96
16	Croker, V. and McDonald, S.	2005		0.92
17	Dardier, V., Bernicot, J., Delanoë, A., Vanberten, M., Fayada, C., Chevignard, M., Delaye, C., Laurent-Vannier, A., and Dubois, B.	2011		0.80
18	De Sousa, A., McDonald, S., and Rushby, J.	2012		0.96
19	De Sousa, A., McDonald, S., Rushby, J., Li, S., Dimoska, A., and James, C.	2010		1.00
20	Doi, R., Morita, K., Shigemori, M., Tokutomi, T., and Maeda, H.	2007		0.95
21	Dresang, H. C. and Turkstra, L. S.	2018		0.95

* Total sum = (number of 'Yes' * 2) + (number of 'Partial' * 1); Total possible sum = 28 - (number of 'N/A' * 2); Summary score = total sum / total possible sum

Table 6 (cont'd)

Quality Ratings (Part 3)

Count	Author(s)	Year	Study	Summary Score
22	Ducharme, J. M., Spencer, T., Davidson, A., and Rushford, N.	2002		0.95
23	Forbes, C. E., Poore, J. C., Barbey, A. K., Krueger, F., Solomon, J., Lipsky, R. H., Hodgkinson, C. A., Goldman, D., and Grafman, J.	2012		0.96
24	Gabbatore, I., Sacco, K., Angeleri, R., Zettin, M., Bara, B. G., and Bosco, F. M.	2015		0.88
25	Genova, H. M., Genualdi, A., Goverover, Y., Chiaravalloti, N. D., Marino, C., and Lengenfelder, J.	2017		0.86
26	Geraci, A., Surian, L., Ferraro, M., and Cantagallo, A.	2010		0.91
27	Godfrey, H. P. D., Knight, R. G., and Bishara, S. N.	1991		0.86
28	Green, R. E. A., Turner, G. R., and Thompson, W. F.	2004		0.95
29	Henry, J. D., Phillips, L. H., Crawford, J. R., Ietswaart, M., and Summers, F.	2006		0.86
30	Honan, C. A., Allen, S. K., Fisher, A., Osborne-Crowley, K., and McDonald, S.	2017		0.88
31	Honan, C. A., McDonald, S., Gowland, A., Fisher, A., and Randall, R. K.	2015		0.95
32	Johnstone, B., Cohen, D., Bryant, K. R., Glass, B., and Christ, S. E.	2015		0.85
33	Kelly, M., McDonald, S., and Kellett, D.	2014		0.91
34	Kelly, M., McDonald, S., and Kellett, D.	2013		1.00
35	Kelly, M., McDonald, S., and Rushby, J.	2017		0.96
36	Kilov, A. M., Togher, L., and Grant, S.	2009		0.83
37	Lew, H. L., Poole, J. H., Chiang, J. Y. P., Lee, E. H., Date, E. S., and Warden, D.	2005		0.82
38	McDonald, S., Gowland, A., Randall, R., Fisher, A., Osborne-Crowley, K., and Honan, C.	2014		0.92
39	McDonald, S., Li, S., De Sousa, A., Rushby, J., Dimoska, A., James, C., and Tate, R. L.	2011		0.96
40	McDonald, S., Rosenfeld, J., Henry, J. D., Togher, L., Tate, R., and Bornhofen, C.	2011		1.00
41	McDonald, S., Rushby, J., Li, S., De Sousa, A., Dimoska, A., James, C., Tate, R., and Togher, L.	2011		0.95
42	McDonald, S., Saad, A., and James, C.	2011		0.91
43	McDonald, S., Togher, L., Tate, R., Randall, R., English, T., and Gowland, A.	2013		0.92
44	Milders, M., Fuchs, S., and Crawford, J. R.	2003		0.95

Table 6 (cont'd)

Quality Ratings (Part 3)

Count	Author(s)	Year	Study	Summary Score
45	Milders, M., Ietswaart, M., Crawford, J. R., and Currie, D.	2006		0.91
46	Milders, M., Ietswaart, M., Crawford, J. R., and Currie, D.	2008		0.95
47	Muller, F., Simion, A., Reviriego, E., Galera, C., Mazaux, J. M., Barat, M., and Joseph, P. A.	2010		0.91
48	Neumann, D., Babbage, D. R., Zupan, B., and Willer, B.	2015		0.96
49	Neumann, D., Malec, J. F., and Hammond, F. M.	2015		1.00
50	Neumann, D., Zupan, B., Babbage, D. R., Radnovich, A. J., Tomita, M., Hammond, F., and Willer, B.	2012		1.00
51	Neumann, D., Zupan, B., Malec, J. F., and Hammond, F.	2014		0.86
52	Osborne-Crowley, K. and McDonald, S.	2016		0.96
53	Radice-Neumann, D., Zupan, B., Tomita, M., and Willer, B.	2009		0.85
54	Rigon, A., Turkstra, L., Mutlu, B., and Duff, M.	2016		1.00
55	Robertson, R. H. and Knight, R. G.	2008		0.96
56	Santoro, J. and Spiers, M.	1994		0.77
57	Saxton, M. E., Younan, S. S., and Lah, S.	2013		0.82
58	Shamay-Tsoory, S. G. and Aharon-Peretz, J.	2007		0.92
59	Shamay-Tsoory, S. G., Tibi-Elhanany, Y., and Aharon-Peretz, J.	2007		0.92
60	Shamay-Tsoory, S. G., Tomer, R., and Aharon-Peretz, J.	2005		0.83
61	Shamay-Tsoory, S. G., Tomer, R., Berger, B. D., and Aharon-Peretz, J.	2003		0.88
62	Shamay-Tsoory, S. G., Tomer, R., Goldsher, D., Berger, B. D., and Aharon-Peretz, J.	2004		0.79
63	Shu, I. W., Onton, J. A., Prabhakar, N., O'Connell, R. M., Simmons, A. N., and Matthews, S. C.	2014		0.91
64	Sim, P., Power, E., and Togher, L.	2013		0.92
65	Simmons, C. D. and Griswold, L. A.	2010		1.00
66	Spikman, J. M., Timmerman, M. E., Milders, M. V., Veenstra, W. S., and van der Naalt, J.	2012		0.92
67	Struchen, M. A., Clark, A. N., Sander, A. M., Mills, M. R., Evans, G., and Kurtz, D.	2008		1.00

Table 6 (cont'd)

Quality Ratings (Part 3)

Count	Author(s)	Year	Study	Summary Score
68	Struchen, M. A., Pappadis, M. R., Sander, A. M., Burrows, C. S., and Myszka, K. A.	2011		1.00
69	Togher, L. and Hand, L.	1999		0.82
70	Togher, L., Hand, L., and Code, C.	1997		0.82
71	Turkstra, L. S., Kraning, S. G., Riedeman, S. K., Mutlu, B., Duff, M., and Vandenheuvel, S.	2017	A	0.91
	Turkstra, L. S., Kraning, S. G., Riedeman, S. K., Mutlu, B., Duff, M., and Vandenheuvel, S.	2017	B	0.86
72	Turkstra, L. S., Norman, R. S., Mutlu, B., and Duff, M. C.	2018		0.95
73	Turkstra, L. S., Quinn-Padron, M., Johnson, J. E., Workinger, M. S., and Antoniotti, N.	2012		0.95
74	Ubukata, S., Tanemura, R., Yoshizumi, M., Sugihara, G., Murai, T., and Ueda, K.	2014		0.90
75	Visser-Keizer, A. C., Westerhof-Evers, H. J., Gerritsen, M. J. J., van der Naalt, J., and Spikman, J. M.	2016		1.00
76	Weddell, R. A. and Wood, R. L.	2018		1.00
77	Westerhof-Evers, H. J., Visser-Keizer, A. C., Fasotti, L., Schönherr, M. C., Vink, M., Van Der Naalt, J., and Spikman, J. M.	2017		0.93
78	Williams, C. and Wood, R. L.	2010		1.00
79	Xi, C., Zhu, Y., Niu, C., Zhu, C., Lee, T. M. C., Tian, Y., and Wang, K.	2011		0.88
80	Zupan, B., Babbage, D., Neumann, D., and Willer, B.	2017		0.95
81	Zupan, B., Neumann, D., Babbage, D. R., and Willer, B.	2015	A	0.90
	Zupan, B., Neumann, D., Babbage, D. R., and Willer, B.	2015	B	0.92

Appendix 7 – List of Assessment Tools

Count	Label
1	[Action comprehension task]
2	[Anger regulation task]
3	[Cartoons task based on collection from other studies]
4	[Computerised eye gaze task using cartoon drawings]
5	[Emotion recognition task based on affective prosody samples]
6	[Exchange structure analysis]
7	[Irony detection task using written scenarios]
8	[Observational measure of child compliance]
9	[Observational measure of social disinhibition]
10	[Recursive and non-recursive questions referring to videotaped scenario]
11	[Stories task based on collection from other studies]
12	[Task based on interpersonal transitive verbs]
13	[Task based on Montreal Set of Facial Displays of Emotion (MSFDE)]
14	[Task based on neutral vs. happy vs. sad baby faces]
15	[Task to elicit naturalistic speech production, high/low ToM conditions]
16	[Task(s) based on Ekman faces]
17	[Theory-of-mind task based on auditory/written scenarios]
18	[Unnamed battery]
19	[Unnamed sarcasm task]
20	[Video vignettes followed by low/high Theory-of-Mind questions]
21	Adapted Stories Task
22	Aprosodia Battery
23	Assessment Battery of Communication (ABaCo)
24	Assessment of Interpersonal Problem-Solving Skills (AIPSS)
25	Bangor Gambling Task (BGT)
26	Cartoon Test
27	Character Intention Task
28	Comprehension and metapragmatic-knowledge task
29	Diagnostic Assessment of Nonverbal Affect 2 - Adult Faces
30	Diagnostic Assessment of Nonverbal Affect 2 - Adult Paralanguage
31	Emotion Recognition Test (ERT)
32	Emotional Inference from Stories Test (EIST)
33	Emotion-in-Context Task (EIC)
34	Evaluation of Social Interaction (ESI)
35	Facial Emotion Identification Task (FEIT)
36	Facial Expression Matching Task
37	Facial Expression Naming Task
38	Facial Expressions of Emotion-Stimuli and Tests (FEEST)
39	False Belief Task
40	Faux-Pas Test

Count	Label
41	Florida Affect Battery (FAB)
42	Florida Affect Battery-Revised (FAB)
43	French Emotion Evaluation Task [French version of TASIT] / Awareness of Social Inferences Test (TASIT-short) [Dutch version]
44	Generic Structure Potential (GSP) of different problem-solving tasks
45	Hinting Task
46	Implicit Association Test (IAT)
47	Iowa Gambling Task
48	Karolinska Directed Emotional Faces test (KDEF)
49	Levels of Emotional Awareness Scale (LEAS)
50	Marital Interaction Coding System (MICS)
51	Mayer-Salovey-Caruso Emotional Intelligence Test (MSCEIT)
52	Mediated Discourse Elicitation Protocol (MDEP)
53	Montreal Evaluation of Communication (MEC) Protocol
54	Moving Shapes Paradigm
55	Prisoner's Dilemma Task
56	Production task: the interview
57	Prosodic Emotion Labelling Task
58	Reading the Mind in the Eyes Test
59	Relationship Closeness Induction Task (RCIT)
60	Risky-Gains Task
61	Sally and Ann Task
62	Sarcasm Comprehension/Mentalistic Interpretation Task
63	Self-Assessment Manikin (SAM)
64	Smarties Task
65	Social Decision Making Task (SDMT) with Cyberball Questionnaire
66	Social Disinhibition Task (SDT)
67	Social Problem Fluency Task
68	Social Problem Resolution Task
69	Social Problem-Solving Test (SPST)
70	Strange Stories Task
71	Task 1: "Expression labelling (context-free)"
72	Task 1: "Rating the intensity of basic emotions expressed by faces"
73	Task 2: "Matching expressions (context-free)"
74	Task 2: "Matching facial expressions with the names of basic emotions"
75	Task 3: "Semantic knowledge of emotions"
76	Task 3: "Sorting facial expressions into emotion categories"
77	Task 4: "Matching facial expressions to context and context-provided expression labelling"
78	Video Social Inference Test (VSIT)

Thesis submitted in partial fulfilment of the examination requirements For the Doctorate in Clinical Psychology (DClinPsy)

Volume 2

Service Evaluation Project

Steffen Nestler
Awarded 1st October 2020

Institute of Psychiatry, Psychology and Neuroscience
King's College London

Service Evaluation Project

National & Specialist CAMHS – Mood & Bipolar Disorders Team

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Doctorate in Clinical Psychology
Institute of Psychiatry, Psychology and Neuroscience
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Word count: 8,239

Depression is a common and often debilitating condition which affects about 3-9% of people under the age of 18 (Kelvin, 2016). Its core symptoms include difficulties lasting at least two weeks of low mood and/or irritability, increased fatigue, loss of enjoyment or interest (ICD-10, 1992). Other symptoms include poor attention or concentration, reduced self-confidence or self-esteem, ideas of worthlessness or guilt, agitation, ideas or acts of self-injurious behaviour or suicide attempts (incl. hopelessness about the future), disturbed sleep (decreased or increased), and significant change in appetite (with noticeable weight loss/gain). Depending on the combination of the above-mentioned symptoms, a depressive episode may be categorized as mild, moderate or severe (Lawton & Moghraby, 2016). The incidence of depression increases around young adulthood (ages 12-18), indicating a potentially sensitive period. In addition, a 2:1 (females:males) gender ratio emerges. For children (ages 7-11), the incidence is closer to 1% with an equal gender ratio (Kelvin, 2016).

The Service

This service evaluation study was conducted in a Tier 4 NHS England national and specialist mental health service for children and adolescents (CAMHS), situated in South London. At the time of data extraction, the service consisted of one full-time and two part-time psychologists, a part-time psychiatrist and a full-time psychiatry trainee, a part-time psychology trainee as well as a part-time assistant psychologist. The service offers care coordination, psychological interventions, and psychiatric management for young people with diagnosable mood or bipolar disorders with referrals being accepted only from other specialist services (i.e., excluding primary care). Reasons for referral may include a lack of response to previous treatment or medication offered, recurrent depression, depression involving psychotic features as well as depression with other complicating factors or co-morbid diagnoses. On average, the service conducts one intake assessment with a young person and their carers, as well as other family members, per week. Assessment and treatment are offered in line with the latest NICE guidelines (2005, 2017), such as cognitive-behavioural therapy (CBT), interpersonal psychotherapy (IPT), and systemic approaches.

Crucially, NICE guidelines recommend (a) “healthcare professionals in primary care settings should be familiar with screening for mood disorders” which is typically achieved using standardized outcome measures and specifically for tier 4 services, (b) “requirement for *intensity of assessment*/treatment and/or level of supervision that is not available in tier 2 or 3” (author’s emphasis). NICE guidance therefore emphasises the use of valid and reliable

outcome measures. In addition, NICE guidelines recommend (c) “when a child or young person has been diagnosed with depression, consideration should be given to the possibility of parental depression” and (d) “*comorbid diagnoses* and developmental, social and educational problems should be assessed and managed, either in sequence or in parallel, with the treatment for depression” (author’s emphasis). This highlights the need, arising from the evidence base collated by NICE, to consider contextual factors in the assessment and diagnosis of depression in children and adolescents. One tool which is central for mental health services to screen for depression in children and adolescents are standardized outcome measures, such as the Mood and Feelings Questionnaire (MFQ; Wood et al., 1995; Lawton & Moghraby, 2016). Significant findings from this project may allow us to refine assessment proceedings (e.g., relative weights to be placed on child vs. parent report), to gain a better understanding of child-parent survey agreement *as it relates to this service*, and ultimately, to offer the most effective treatment interventions. Literature on child-parent agreement on depression measures exists, but is relatively sparse (see below). In this study, we sought to investigate the relationship between young people’s own perception of their mood problems and comorbid symptoms, their parents’ perception as well as parents’ own report of mental health difficulties using the statistical approach of moderation.

Co-morbidities in Depression

Depression in young people is substantially comorbid with a variety of anxiety disorders (e.g., social phobia, generalized anxiety, specific phobia, panic disorder, separation anxiety, and obsessive-compulsive disorder). Point prevalence rates vary depending on the selection of anxiety diagnoses, but tend to vary between 2.6-4.1% (Cartwright-Hatton et al., 2006). Anxiety disorders, again with some variation depending on the diagnosis, may begin manifesting in early to middle childhood. Some children and young people’s presentations may also shift between pre-defined anxiety disorders (Schleider et al., 2014). Crucially, depression and anxiety have a high rate of comorbidity, ranging between 20 to 50% (Ollendick et al., 2005). However, there tends to be a predominance of children and young people with a primary diagnosis of depression and a comorbid anxiety disorder rather than vice versa (ibid.). Interestingly, depression tends to be more prevalent in adolescence, with anxiety difficulties emerging earlier in childhood, while adolescents with comorbid depression and anxiety diagnoses tend to be older than those with a single diagnosis. In addition, Schleider et al. (2014) explicitly include familial factors in their proposed model for the development of secondary depression following a primary anxiety diagnosis. A common measure to screen for anxiety diagnoses is the Screen for Child Anxiety and Related Emotional Disorders (SCARED; Muris et al., 1998). This measure contains items pertaining

to panic disorder, generalized anxiety disorder, social phobia, separation anxiety, obsessive-compulsive disorder, traumatic stress disorder, and specific phobias. In addition, the present service uses the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997) to check for more generic behavioural, emotional or relational difficulties in our young clients. As a result of the substantial and common co-morbidity with other psychiatric disorder, we examined not just symptoms of depression (MFQ), but also anxiety (SCARED) and more global difficulties (SDQ) in a specialist mood disorders clinic.

Child-Parent Agreement in Depression

Generic child-parent agreement. Evaluating prior literature regarding child-parent agreement on depression and related ratings reveals a mixed picture. Earlier work by Muris et al. (2003) found a moderate correlation between child and parent ratings for depression (Pearson's $r = 0.50$, $p < 0.001$) on the Revised Children's Anxiety and Depression Scale (RCADS) while some anxiety symptoms were over-, some under-estimated, depending on the disorder in question, with correlations ranging between 0.33-0.51 (all p's < 0.001). Rothen et al. (2009) found parent-child agreement on the Kiddie Schedule for Affective Disorders and Schizophrenia (K-SADS) to be particularly poor for anxiety disorders, but "fair to good" for depression, with minor variations between mothers and fathers. Vidair et al. (2011) investigated low-income, Hispanic parents in primary practice. Those with sub-threshold depression symptoms and or an explicit depression diagnosis were significantly more likely to endorse that their children demonstrated behavioural problems (such as temper tantrums, inattentiveness or disobeying rules) than parents with no depressive symptoms. Breland-Noble and Weller (2012) reviewed parent-child and clinician-child agreement in 35 youth from a non-clinical community sample, finding substantially higher agreement concordance in the latter. Ramírez-GarcíaLuna et al. (2016) investigated young people's depressive symptoms using the Children Depression Inventory in a sample of 284, out of which 47 noted depressive symptoms, and compared these to parents' ratings of the young person's difficulties on the SDQ. The correlation they found was moderate and suggests that parents may sometimes struggle to identify their children's negative emotions or conduct difficulties as possible signs of underlying depression.

Child-parent agreement in the context of parental depression. Lewis et al. (2012) followed a longitudinal sample of 287 parents with recurrent depression and their offspring over three time points. Out of these, 36 young people developed depression. There was good agreement between parents and children on the Child and Adolescent Psychiatric Assessment for a "new onset mood disorder," though this was slightly better for older

children (aged 12+ years). The authors report having replicated their results using the SDQ, but these findings were not published. Lastly, Milan et al. (2017) probed mothers' and daughters' ratings of each other's depression, finding comparable levels of accuracy between the two. In addition, they discovered that the relationship between daughters' and mothers' ratings of each others' depressive symptoms was moderated by attachment style, such that "among adolescents reporting high depressive symptoms, these symptoms were observed by mothers only in dyads characterized by high adolescent preoccupation."

Child-Parent Agreement on Relevant Questionnaires

MFQ. Previous research has also investigated the parent-child agreement on the questionnaires used in this study. Stevanovic et al. (2012) issued the MFQ and SCARED to 56 pairs of children and their parents. Notably, the children all had diagnoses of epilepsy. The group found no significant differences in the total scores of either scales. Inter-rater agreement was moderate to substantial for the MFQ and SCARED, with the exception of the social phobia subscale for which it was poor. The child's age was related to child-parent discrepancy only for the generalized anxiety and specific phobia subscales of the SCARED. As a result, the authors recommend the inclusion of both raters for the assessment of anxiety and depression in this population. Hammerton et al. (2014) evaluated the predictive quality of child (ages 9-17) and parent ratings from the MFQ in the context of the development of a four-item short form with 337 families. Using ROC analyses, the authors concluded that parent and child ratings were comparably predictive of future suicidal ideation, whereas the child ratings only were more predictive of contemporaneous suicidal ideation.

SCARED. Wren et al. (2006) found in a sample of 515 children (ages 8-12) and parents seen in US primary care that children reported significantly greater anxiety symptoms on the SCARED than their parents, particularly for younger children (<10 years). Girls also reported significantly more anxiety than boys, but this was not reflected in their parents' ratings. In this study, the findings were largely independent of the families' ethnic affiliation and the core SCARED factor structured was maintained across ethnic groups. Cosi et al. (2010) recruited 394 children (ages 9-13) with their parents through mainstream schools in Spain. Children tended to report significantly more anxiety symptoms on the SCARED than their parents leading to between low and moderate correlations between their scales; this finding was independent of children's gender. Using the Mini-International Neuropsychiatric Interview for Children and Adolescents outcome variable in a regression, children's ratings were the best

predictors of possible anxiety diagnoses with parents' ratings only adding 1.1-4.2% of variance, depending on the disorder subscale.

SDQ. Van der Meer et al. (2008) examined children (ages 11-18) and parent ratings on the SDQ in a clinical sample from Sydney, Australia (379 families) where the young person had at least one mental health diagnosis. Based on their ratings, the sample was grouped into "neither", "both", "child only" or "parent only" agreeing that the young person experienced difficulties in the clinical range. Although a comparison of overall scores found poor agreement, pairs in the "both" and "neither" groups made up the majority of the sample. Interestingly, 46% of the sample fell into "neither" group, with parents and children agreeing that the young person did not meet a clinical threshold despite their diagnosis, and the smallest group was "child only" (n = 17). Internalizing (mood) disorders were over-represented in the "child only" group, whereas externalizing disorders (e.g., ADHD and conduct problems) were over-represented in the "parent-only" group. This relationship was independent of the child's age, though females more likely fell into the "child only" and "neither groups" and boys more likely into the "parent only" and "both" groups. Stokes et al. (2014) investigated child-parent agreement in an 854-strong sample from Malaysia. They found overlap in the underlying model used for ratings by children (ages 6-17) and parents using confirmatory factor analysis, though also commented on the higher likelihood of parents to report hyperactivity in their sons than in their daughters.

Taken together, these studies also reveal a complex picture with regard to parent-child agreement on children's psychological symptoms. For the present project, it was decided to try and use, wherever possible, parent and child versions of the same measure in order to reduce potential contamination through different symptom groupings or verbal formulations.

Age and Gender Differences in Depression

There are consistent findings in the literature that females are more likely to report depressive symptoms than males. For instance, Bebbington et al. (1998, 2003) found in a survey of 9,792 participants from the British population that women endorsed depressive symptoms significantly more often than males up to the age of about 55 years. One hypothesis as to the causes of such findings is a male response bias which suggests that men underreport depressive symptoms compared to women. This was substantiated in a study by Sigmon et al. (2005). The authors found that men, but not women, endorsed fewer symptoms when it was suggested that their ratings would be followed up. The endorsement of signs of low mood was also correlated with measures of beliefs about depression, more

general mental health beliefs, and gender-related traits, depending on the respondent's gender. Berger et al. (2012) added to the theory by investigating possible further contextual factors which may account for gendered response patterns. They found that men were less likely to report symptoms in an online questionnaire when the term "depression" was used and when this was associated with a causal theory of depression which emphasized an external locus of control (e.g., biological or environmental explanations). Conversely, in a study by Silverstein et al. (1998), the authors found that female college students who believed that their fathers had negative attitudes about their gender and/or that their mothers faced particular challenges in their lives because of their gender scored significantly higher in terms of depression symptoms alongside anxious somatic symptoms. However, this gender divide was not found for depression symptoms without the anxious somatic component. Gender differences have also been found on depression rating scales, such as the Beck Depression Inventory (BDI; Waelde et al., 1994), the Hamilton Depression Scale (Camozzato et al., 2007), and the Depression Self-Rating Scale (DSRS; Seyed-Hossein, 2007). Reports on electronic or online platforms can also exhibit the aforementioned gender bias, both in elicited (e.g., questionnaires; Ybarra et al., 2004) and voluntarily declared contexts (e.g., online fora; Hausner et al., 2008).

In addition, age is a decisive factor in the development of depression with adolescence being a critical and sensitive period. The incidence rate increases sharply from 1% in childhood to between 3 and 8% in adolescence (Gledhill & Hodes, 2015). A variety of risk factors have been put forward for this finding, including genetic (Frani et al., 2010; Xia & Yao, 2015), neuroscientific (Blom et al., 2016), information processing (Lau & Waters, 2017), and community-level (Stirling et al., 2015) narratives. One biopsychosocial model (Oldehinkel et al., 2014) posits that childhood adversity may be involved in early-onset depression (through stress sensitization, amplification or inoculation), but not late-onset depression, depending on the stressfulness of the environment at the time. The current project does not favour one model over others, but focusses rather on an empirical investigation of the relationship between child and parent perceptions of depressive symptoms in a specialist service environment.

Lastly, there is evidence to suggest that age and gender differences may interact. For instance, gender differences in the endorsement of depression symptoms are not present at elementary school age (Berg & Klinger, 2009), emerge around puberty/adolescence (Girgus & Young, 2015), and decline after menopause (Bebbington et al., 2003). Gender differences have been found to extend to anxiety symptoms in adolescents (Puskar et al., 2009) and

undergraduate students (McLean & Hope, 2010). We included age and gender as covariates in the statistical models wherever possible.

Summary of background literature. In sum, some studies have found good agreement between parents' ratings of their children's depression symptoms, while others have only found moderate agreement. Differences in agreement have been linked to a variety of potential intervening variables, such as parents' gender, parents' own level of depressive symptoms, age of the young person, attachment style as well as the type and overlap between measures being employed.

Study Goals

Consequently, there are indications in the literature that young people's ratings of their depressive symptoms can be influenced by contextual factors, such as comorbidities (e.g., anxiety), age and/or gender. Furthermore, evaluations of their symptoms on standardized screening questionnaires by young people and their parents may diverge. There is some tentative evidence to suggest that parents' and carers' views on the young person's symptoms may be influenced by the presence or experience of their own depression. In line with the service aims, we strived to investigate the efficacy of standardized outcome measures in assisting for the assessment of depressive symptoms in young people using existing data.

This service evaluation project investigated to what extent this might be the case, using correlational and moderation approaches, in a UK Tier 4 national and specialist Mood & Bipolar Disorders outpatient service in South London, England. In addition, we were interested whether a diagnosis of depression might be influenced by certain contextual factors which may confer a level of severity.

Therefore, we hypothesized that:

1. Child (C-MFQ) and parent (P-MFQ) measures of depression will be correlated.
    a. The correlation will be moderated by parental depression (HADS-D).
    b. The HADS-D moderation effect may be altered by the inclusion of age or gender covariates, but will remain significant.
    c. Child measures of depression (C-MFQ) will be more predictive of a depression diagnosis resulting from the intake assessment than parental measures (P-MFQ).

   d. Child measures of depression (C-MFQ) will also be more predictive of a depression diagnosis than either the young person's age or gender.
2. Child (C-SCARED) and parent (P-SCARED) measures of anxiety will be correlated.
   a. The correlation will be moderated by parental anxiety (HADS-A).
   b. The HADS-A moderation effect may be altered by the inclusion of age or gender covariates, but will remain significant.
   c. Child measures of anxiety (C-SCARED) will be more predictive of an anxiety diagnosis resulting from the intake assessment than parental measures (P-SCARED).
   d. Child measures of anxiety (C-SCARED) will also be more predictive of an anxiety diagnosis than either the young person's age or gender.
3. Child (C-SDQ) and parent (P-SDQ) measures of functional difficulties will be correlated.
   a. The correlation will be moderated by a measure of parental depression and anxiety (HADS-T).
   b. The HADS-T moderation effect may be altered by the inclusion of age or gender covariates, but will remain significant.
   c. Child measures of functional difficulties (C-SDQ) will be more predictive of either a depression or anxiety diagnosis resulting from the intake assessment than parental measures (P-SDQ).
   d. Child measures of functional difficulties (C-SDQ) will also be more predictive of a depression or anxiety diagnosis than either the young person's age or gender.
4. Greater 'severity' (considering whether the young person has previously been admitted to hospital, has received prior psychological treatment, was attending hospital for a medical reason at the time of the assessment and whether the young person was engaging in suicidal or non-suicidal self-injury) will be correlated with receiving a diagnosis of depression, anxiety, or either of these.

Methods

Participants. The sample represents 194 young persons and their parents/carers assessed consecutively at an initial appointment at a South London, UK, national and specialist clinic for mood and bipolar affective disorders. They completed measures relating to assessments between March 2009 and September 2017.

Measures. The Mood and Feelings Questionnaire (MFQ) contains child (C-MFQ) and parent (P-MFQ) versions for the assessment of depressive disorders in young people. Both versions offer good internal consistency (Cronbach's α = 0.92 and 0.94, respectively). The C-MFQ has good test-retest reliability (ICC = 0.78; Wood et al., 1995). Findings for the MFQ's diagnostic accuracy have been mixed, with one publication ranking the child version as having "moderate diagnostic accuracy" and the parent version as "low" (Wood et al., 1995) while another publication found the parent version more predictive of a depression diagnosis (Kent et al., 1997), though the latter covaried for gender effects. Both publications found a moderate correlation between the two measures (0.51; Wood et al., 1995; Kent et al., 1997).

The Screen for Child Anxiety Related Emotional Disorders (SCARED) offers good internal consistency for both its child (C-SCARED; Cronbach's α = 0.93) and parent versions (P-SCARED; α = 0.94; Muris et al., 2004). Child-parent agreement was reported to be correlated at 0.69, though this could vary between 0.50 (social phobia) and 0.70 (panic disorder), depending on the disorder in question. The SCARED further provides good predictive validity with *OR*'s between 1.12 to 2.34, depending on the anxiety disorder. Additional research has shown that the SCARED may correlate with measures of childhood depression (Muris et al., 1998).

The Strengths and Difficulties Questionnaire (SDQ) is a general-purpose questionnaire which has been employed in schools and clinical services to screen for difficulties related to hyperactivity, emotional symptoms, conduct problems, peer relations as well as pro-social skills. Parent, child, and teacher versions exist, though the last was not considered here. The parent version (P-SDQ) achieved a ROC curve area of 0.87 for diagnostic discriminative ability (Goodman et al., 1997). The scale achieved good internal consistency (Cronbach's α = 0.70). Parent-child agreement was moderate (Pearson's r = 0.48). The SDQ's test-retest reliability was estimated at 0.62 (Goodman et al., 2001).

Statistical analyses. Statistical computations were performed using SPSS (Version 24; IBM, 2017). Frequencies were obtained using standard descriptives. Correlations were calculated with Pearson's *r* (hypotheses 1, 2, and 3). Moderation analyses were carried out with Hayes' PROCESS model (Hayes & Rockwood, 2016; H1a, H1b, H2a, H2b, H3a and H3b). Linear regressions followed a stepwise model (H1c, H1d, H2c, H2d, H3c and H3d). Hypothesis 4 was investigated using Spearman's ρ given the non-parametric nature of the variables involved.

Specifically regarding H4, correlations were calculated between variables denoting whether someone had met criteria for a depression diagnosis, anxiety diagnoses, or either of these following their intake assessment at the clinic and binary variables relating to whether the client had had a prior hospital admission due to their mental health, had received previous psychological treatment, had a history of suicidal or non-suicidal self-injury, had been admitted to hospital for a physical health concern (all coded as 'yes' = 1, 'no' = 0) as well as a dummy variable representing a combination of the four preceding variables (score of 0-4). Due to the number of correlations, a family-wise error correction was applied according to Šidák (1967): 1-(1-α)^(1/m) – α denotes the significance level, m the sum of comparisons.

The assumptions of multi-coliniarity in the moderation analyses (H1a, H2a, and H3a) were investigated using Pearson's *r* correlations between the dependent variable and the hypothesized moderator. The correlations were of small size (r = 0.20 between P-MFQ and HADS-D; r = 0.17 between P-SCARED and HADS-A; r = 0.18 between P-SDQ and HADS-T) and none of them were significant (p > 0.06). Therefore, the criterion of multi-coliniarity was not violated. The assumptions of normal distribution, homogeneity, and homo-schedasticity were investigated visually using histograms, q-q plots, and scatterplots of the moderator variables, respectively (HADS-D for H1a, HADS-A for H2a, and HADS-T for H3a). No significant abnormalities were observed.

Power. The moderation and regression analyses (hypotheses 1a-d, 2a-d, and 3a-d) required a power calculation to establish suitable sample sizes. G*Power (v3.1; University of Düsseldorf, 2009) states that, in order to detect a small effect size (f^2 = 0.15) with the α-level at 0.05, power (1-β) of 0.8 and up to 4 predictors, a minimal sample size of at least 84 is required. With sample sizes of 87 (H1a & H1b), 145 (H1c & H1d), 88 (H2a & H2b), 142 (H2c & H2d), 79 (H3a & H3b), and 139 (H3c & H3d), all but H3a and H3b sample sizes were sufficient.

Results

Demographics. The young people making up the study sample were predominantly female with an average age of 14.8 years (SD = 2.27 years, range: 6-18 years). Further details were extracted from medical records (e.g., previous mental health admissions), targeted assessment questions (e.g., for self-harm) or a mix of both (e.g., concurrent medical treatment) and coded as "present" or "absent." Most clients had not been admitted to hospital before, but had received prior psychological care. A slightly greater number reported suicidal or non-suicidal self-injury than did not and stated not having been in receipt of medical care for a non-mental health-related condition than had not. Treatment offers were recorded during multi-disciplinary consultations. Roughly two thirds of clients were offered treatment following the intake assessment by the multi-disciplinary team consisting of psychiatrists, psychologists, and trainees from either profession. Most clients who received a diagnosis qualifying them to be seen by the team (MDC) were offered combination treatment, consisting of medical support (e.g., pharmacology, risk management) and psychological therapy. The primary mode of talking therapy put forward was cognitive behavioural therapy (CBT; see Table 1).

Table 1

Demographic Variables

Variable	Majority Group	Count	Percentage	Percent Missing
Gender	Female	125	64.4%	0.0%
	Male	69	35.6%	
Ethnicity	White	88	45.2%	
	Mixed Background	17	8.7%	
	Asian or Asian British	6	3.0%	
	Black or Black British	15	7.6%	6.7%
	Other Ethnic Groups	17	8.7%	
	British, no race specified	38	19.6%	

Prior hospital admission (for mental health)	No	140	72.2%	4.6%
	Yes	45	23.2%	
Previous psychological treatment	No	56	28.9%	5.2%
	Yes	128	66.0%	
Prior hospital treatment (for physical health)	No	94	48.5%	6.7%
	Yes	87	44.8%	
History of (non-) suicidal self-injury	No	88	45.4%	6.2%
	Yes	94	48.5%	
Treatment offered by MDC?	Yes	124	63.9%	12.9%
	No	45	23.2%	
Treatment type (general)	Combination	83	42.8%	
	Psychology	41	21.1%	10.8%
	Medication	4	2.1%	
	n/a	45	23.2%	
Treatment type (psychology)	CBT	109	56.2%	
	IPT	3	1.5%	36.1%
	CBT or IPT	3	1.5%	
	FBI*	4	2.1%	
	n/a	5	2.6%	

**FBI = family-based intervention (for bipolar affective disorder).*

Correlations. Child and parent ratings of young people's depression (C-MFQ and P-MFQ, respectively) were significantly correlated ($n = 145$, $p < 0.001$; hypothesis 1). The correlation was of medium strength ($r = 0.54$). A post-hoc paired-samples *t*-test showed that Child ratings were significantly higher ($M_C = 37.7$, $SD_C = 15.79$) than parent ratings ($M_P = 32.9$, $SD_P = 15.43$; $t = 3.86$, $p < 0.001$).

Child and parent ratings of young people's anxiety (C-SCARED and P-SCARED, respectively) were also significantly correlated ($n = 142$, $p < 0.001$; hypothesis 2). The correlation was of medium strength ($r = 0.62$). A post-hoc paired-samples *t*-test showed that Child ratings were significantly higher ($M_C = 41.2$, $SD_C = 18.68$) than parent ratings ($M_P = 32.4$, $SD_P = 17.71$; $t = 6.58$, $p < 0.001$).

Child and parent ratings of young people's functional difficulties (C-SDQ and P-SDQ, respectively) were significantly correlated ($n = 139$, $p < 0.001$; hypothesis 3). The correlation was of medium strength ($r = 0.57$). A post-hoc paired-samples *t*-test again showed that Child ratings were significantly higher ($M_C = 20.3$, $SD_C = 7.12$) than parent ratings ($M_P = 19.1$, $SD_P = 17.82$; $t = 6.82$, $p = 0.03$).

Moderation analyses. For the purpose of the moderation analyses, HADS scores were converted into categorical variables using clinical cut-offs. The cut-offs were set at 8 for the depression and anxiety subscales (HADS-D and HADS-A) as well as at 16 for the overall scale (HADS-T) according to Bjelland et al. (2002).

For the depression model (hypothesis 1a), with C-MFQ as outcome variable, P-MFQ as predictor, and HADS-D as moderator, a significant result was achieved for the overall model – $F(3, 83) = 7.50$, $p < 0.001$, $R^2 = 0.24$. The child MFQ was significantly predicted by the parent MFQ – $b = 0.44$, $t(83) = 4.17$, $p < 0.001$, meaning that for every 1-point increase on the P-MFQ, there is an average 0.44-point decrease on the C-MFQ (95% CI 0.23-0.65). However, the moderation effect was not significant – $b = 2.93$, $p = 0.41$. Results were comparable when HADS-D was entered as a continuous variable ($F(3, 83) = 7.63$, $p < 0.001$, $R^2 = 0.23$).

For the anxiety model (hypothesis 2a), with C-SCARED as outcome variable, P-SCARED as predictor, and HADS-A as moderator, a significant result was achieved for the overall model – $F(3, 84) = 21.11$, $p < 0.001$, $R^2 = 0.39$. The child SCARED was significantly predicted by the parent SCARED – $b = 0.62$, $t(84) = 7.28$, $p < 0.001$, meaning that for every 1-point increase on the P-SCARED, there is an average 0.62-point decrease on the C-SCARED (95% CI 0.45-0.79). However, the moderation effect was not significant – $b = 2.62$, $p = 0.43$. Results were comparable when HADS-A was entered as a continuous variable ($F(3, 84) = 22.09$, $p < 0.001$, $R^2 = 0.41$).

For the strengths-and-difficulties model (hypothesis 3a), with C-SDQ as outcome variable, P-SDQ as predictor, and HADS-T as moderator, a significant result was achieved for the

overall model – $F(3, 75) = 6.81$, $p < 0.001$, $R^2 = 0.31$. The child SDQ was significantly predicted by the parent SDQ – $b = 0.53$, $t(75) = 3.72$, $p < 0.001$, meaning that for every 1-point increase on the P-SDQ, there is an average 0.53-point decrease on the C-SDQ (95% CI 0.25-0.81). However, the moderation effect was not significant – $b = 1.26$, $p = 0.38$. Results were comparable when HADS-T was entered as a continuous variable ($F(3, 75) = 7.08$, $p < 0.001$, $R^2 = 0.31$).

For the impact of age and gender, the above models were repeated with either age or gender as covariates in the moderation models (hypotheses 1b, 2b, and 3b). HADS scores were again added both as categorical and continuous variables.

A significant moderation was obtained with parent SCARED scores predicting child SCARED scores and HADS-Anxiety as a continuous moderator variable while gender served as a covariate – $b = 0.83$, $p = 0.02$ (hypothesis 2b). The overall model was significant – $F(4, 84) = 19.32$, $p < 0.001$, $R^2 = 0.43$. The gender covariate itself was not significant in this model ($p = 0.20$).

Another significant moderation was obtained with the above model (P-SCARED, C-SCARED, HADS-Anxiety [continuous]), but age as a covariate – $b = 0.75$, $p = 0.04$. The overall model was significant – $F(4, 83) = 16.94$, $p < 0.001$, $R^2 = 0.41$. The age covariate itself was not significant in this model ($p = 0.96$).

As an explorative control, age and gender were added as covariates into the same model. The moderation effect remained, only marginally weakened from the first finding – $b = 0.82$, $p = 0.02$. The overall model was significant – $F(5, 82) = 15.24$, $p < 0.001$, $R^2 = 0.43$ –, but neither gender ($p = 0.19$) nor age ($p = 0.94$) as covariates were. The remaining models with age and gender were significant, but none of the moderation terms were (hypotheses 1b and 3b; see Table 2).

Table 2

Moderation: Covarying for Age and Gender

Model	Covariate	Deg. of Freedom (*f*)	*F*	*p*	R^2
Y: C-MFQ; X: P-MFQ; M: HADS-Dep. (categ.)	Age	4, 82	6.89	<0.001	0.28

Y: C-MFQ; X: P-MFQ; M: HADS-Dep. (cont.)	Age	4, 82	7.30	<0.001	0.26
Y: C-SCARED; X: P-SCARED; M: HADS-Anx. (categorical)	Age	4, 83	15.69	<0.001	0.39
Y: C-SCARED; X: P-SCARED; M: HADS-Anx. (continuous)	Age	4, 83	16.94	<0.001	0.41
Y: C-SDQ; X: P-SDQ; M: HADS-Total (categ.)	Age	4, 74	6.46	<0.001	0.33
Y: C-SDQ; X: P-SDQ; M: HADS-Total (cont.)	Age	4, 74	6.17	<0.001	0.32
Y: C-MFQ; X: P-MFQ; M: HADS-Dep. (categ.)	Gender	4, 82	7.09	<0.001	0.27
Y: C-MFQ; X: P-MFQ; M: HADS-Dep. (cont.)	Gender	4, 82	7.92	<0.001	0.26
Y: C-SCARED; X: P-SCARED; M: HADS-Anx. (categorical)	Gender	4, 83	17.88	<0.001	0.40
Y: C-SCARED; X: P-SCARED; M: HADS-Anx. (continuous)	Gender	4, 83	19.32	<0.001	0.43
Y: C-SDQ; X: P-SDQ; M: HADS-Total (categ.)	Gender	4, 74	7.35	<0.001	0.35
Y: C-SDQ; X: P-SDQ; M: HADS-Total (cont.)	Gender	4, 74	7.34	<0.001	0.34

Abbreviations: MFQ = Mood and Feelings Questionnaire; SCARED = Screen for Child Anxiety Related Emotional Disorders; SDQ = Strengths and Difficulties Questionnaire; HADS = Hospital Anxiety and Depression Survey; 'C' refer to child, 'P' to parent versions.

Regression analyses. The overall depression model (hypotheses 1c and 1d) with child diagnosis of depression (yes/no) as dependent variable as well as Age, Gender, child MFQ, and parent MFQ as predictors in separate blocks was significant – $N = 145$, χ^2 (3) = 11.83, $p = 0.02$. Age as an individual predictor was significant ($OR = 1.17$, $p = 0.046$). However, this was no longer the case when Gender ($p = 0.07$), Gender and C-MFQ ($p = 0.18$) or Gender, C-MFQ and P-MFQ were added as predictors ($p = 0.17$). C-MFQ remained as a significant predictor in the final model ($OR = 1.03$, $p = 0.022$). However, P-MFQ was not a significant predictor ($p = 0.73$; see Table 3).

Table 3

*Regression: Age & Depression (MFQ**)*

Variables		Odd's Ratio	Sig. (*p*)
Block 1:	Age	1.17	0.046*
Block 2:	Age	1.16	0.07
	Gender	0.66	0.25
Block 3:	Age	1.12	0.16
	Gender	0.80	0.55
	Child-MFQ	1.03	0.014*
Block 4:	Age	1.12	0.17
	Gender	0.78	0.52
	Child-MFQ	1.03	0.022*
	Parent-MFQ	1.00	0.73

*** = Mood and Feelings Questionnaire; * =* p *< 0.05.*

The overall anxiety model (hypothesis 2c and 2d) with child diagnosis of any anxiety disorder (yes/no) as DV as well as Age, Gender, child SCARED, and parent SCARED as predictors, each in a separate block, was significant – $N = 142$, χ^2 (3) = 38.87, $p < 0.001$. Age did not survive as a significant predictor at any stage of the model (p's > 0.49). C-SCARED was a comparatively even predictor without ($OR = 1.07$, $p < 0.001$) or with ($OR = 1.06$, $p < 0.001$) P-SCARED in the model. P-SCARED did not manage to add significant prediction value ($p = 0.38$); neither did Gender (p's > 0.41; see Table 4).

Table 4

Regression: Age & Anxiety (SCARED†)

Variables		Odd's Ratio	Sig. (*p*)
Block 1:	Age	1.06	0.52
Block 2:	Age	1.05	0.59
	Gender	0.74	0.41
Block 3:	Age	1.07	0.53
	Gender	0.94	0.89
	Child-SCARED	1.07	< 0.001**

Block 4:	Age	1.07	0.48
	Gender	0.93	0.87
	Child-SCARED	1.06	< 0.001**
	Parent-SCARED	1.01	0.38

*† = Screen for Child Anxiety Related Disorders; ** =* p *< 0.005.*

The joint depression/anxiety regression model (hypothesis 3c and 3d) with child diagnosis of either a depression or anxiety diagnosis as DV as well as Age, Gender, child SDQ, and parent SDQ as predictors, each in their separate block, overall just missed being significant – $N = 139$, χ^2 (3) = 8.73, $p = 0.068$. Neither age, nor gender were a significant predictor at any stage in the model (p's > 0.22). C-SDQ was a predictor in the model without P-SDQ (χ^2 (2) = 8.24, $p = 0.041$; $OR = 1.08$, $p = 0.022$; see Table 5). However, neither C-SDQ (p = 0.12) nor P-SDQ ($p = 0.49$) served as predictors in the final model.

Table 5

Regression: Age & Depression/Anxiety (SDQ‡)

Variables		Odd's Ratio	Sig. (*p*)
Block 1:	Age	1.13	0.28
Block 2:	Age	1.15	0.22
	Gender	1.87	0.22
Block 2:	Age	1.11	0.38
	Gender	1.77	0.27
	Child-MFQ	1.08	0.022*
Block 3:	Age	1.11	0.40
	Gender	1.71	0.31
	Child-MFQ	1.06	0.12
	Parent-MFQ	1.03	0.49

*‡ = Strengths and Difficulties Questionnaire; * =* p *< 0.05.*

Exploration of severity indicators. In total, 15 correlations were performed, leading to a corrected α-level of 0.003. No correlations were significant at the corrected level (hypothesis 4).

At the uncorrected level ($\alpha = 0.05$), the receipt of a new or additional depression diagnosis was correlated with a history of suicidal or non-suicidal self-injury, albeit to a small degree ($\rho = 0.15$, $p = 0.042$). The correlation with a previous hospital admission for a mental health concern approached the uncorrected significance level, but was in the opposite than expected direction ($\rho = -0.14$, $p = 0.07$), meaning if a client had had a prior admission, they were potentially *less* likely to be given a depression diagnosis or have an original diagnosis confirmed by the team. The predominant primary diagnoses given alternatively were bipolar affective disorder ($n = 31$, 42.5%) and a variety of anxiety disorders (e.g., social phobia, generalized anxiety disorder; $n = 13$, 18%). All other correlations were not significant (p's > 0.64; see Table 6).

The receipt of an anxiety diagnosis was not correlated with any of the above five variables (p's > 0.15; see Table 6).

At the uncorrected significance level, a history of suicidal or non-suicidal self-injury was correlated with receiving either a depression or an anxiety diagnosis; the correlation was small ($\rho = 0.16$, $p = 0.028$). The correlations involving previous psychological treatment ($\rho = 0.14$, $p = 0.063$) and prior admission to hospital for a mental health concern ($\rho = -0.13$, $p = 0.085$) approached the uncorrected significance level; once more, the latter correlation was not in the expected direction. The remaining correlations were not significant (p's > 0.41; see Table 6).

Table 6

Correlations of Diagnostic Categories with Severity Indicators

Variable 1	Variable 2	*N*	Spearman's ρ	Sig. (p)
Any depression diagnosis	Previous hospital (mental health)	185	-0.14	0.07
	Prior psychological treatment	184	-0.03	0.65
	History of self-injury / suicide attempt	182	0.15	0.04*
	Previous hospital (non-mental health)	181	-0.03	0.70

	Combination of the above four variables	189	0.02	0.84
	Previous hospital (mental health)	185	-0.09	0.25
	Prior psychological treatment	184	0.09	0.20
Any anxiety diagnosis	History of self-injury / suicide attempt	182	0.06	0.46
	Previous hospital (non-mental health)	181	-0.11	0.16
	Combination of the above four variables	189	-0.04	0.62
	Previous hospital (mental health)	185	-0.13	0.09
	Prior psychological treatment	184	0.14	0.06
Any depression or anxiety diagnosis	History of self-injury / suicide attempt	182	0.16	0.03*
	Previous hospital (non-mental health)	181	-0.06	0.42
	Combination of the above four variables	189	0.06	0.43

* $p < 0.05$.

Discussion

In sum, child and parental ratings of the young person's depressive symptoms on the MFQ were moderately correlated (hypothesis 1) and children's ratings, on average, were significantly higher than parental ratings by 4.8 points. No significant moderating effect of the depression subscale from the parental HADS was found on the correlation between child and parent ratings of depression on the MFQ, showing no evidence for hypothesis 1a. The moderation effect was not substantially altered by age or gender as covariates (hypothesis 1b). The child-rated MFQ was more predictive of a new or additional depression diagnosis than the parent-rated version (hypothesis 1c), and this was not limited by the inclusion of

age or gender as factors in the regression analysis. However, age on its own was also predictive of a new or additional depression diagnosis (hypothesis 1d).

Child and parent ratings of the young person's anxiety symptoms on the SCARED were moderately correlated (hypothesis 2) and on average, children's ratings were significantly higher than parental ratings by 8.8 points. No significant moderating effect of the anxiety subscale from the parental HADS was found on the correlation between child and parent ratings of anxiety on the SCARED within the standard model (not supporting hypothesis 2a). When, however, age, gender or both were added into the model as covariates, while the total score from the HADS anxiety subscale has been added as a continuous variable, the moderation did become significant, lending some support to hypothesis 2b. The child-rated SCARED was a strong predictor of a new or additional anxiety diagnosis over and above age, gender, and the parent-rated SCARED, none of which added significant variance to the regression model (hypothesis 2c and 2d).

Child and parent ratings of the young person's strengths and difficulties on the SDQ were moderately correlated (hypothesis 3). On average, children's ratings were significantly higher than parental ratings, though only by 1.2 points. No significant moderating effect of the parental HADS total emerged on the correlation between child and parent ratings of symptoms on the SDQ (hypothesis 3a). This result was not altered by the addition of age or gender as covariates (hypothesis 3b). The child-rated SDQ would have predicted a new or additional diagnosis of either anxiety or depression with age and gender as predictors in the regression. However, the overall model was not significant, and neither was the child-rated SDQ when the parent-rated SDQ was added into the equation, lending no support to hypotheses 3c or 3d.

In an exploratory analysis, correlations were found in the present sample between a history of suicidal or non-suicidal harm and the receipt of a new or additional diagnosis of depression as well as a new or additional diagnosis of depression or anxiety (though not anxiety individually). However, these correlations were only significant at a level uncorrected for multiple analyses.

There is some overlap between these findings and the extant literature, but also some disparities. Muris et al. (2003), for instance, found a moderate correlation between child and parent ratings for depression symptoms, though on the RCADS rather than the MFQ. Kobayashi and Kamibeppu (2011) found that parents rated their children's symptoms higher than the young people did themselves. It can however not be excluded that this is related to

cultural factors in parent-child relations or the interpretation of depressive symptoms. In a related vain, Cole et al. (2002) discovered that parent-child agreement about the rate of symptom change was stronger than agreement about time-specific symptoms in their longitudinal approach. For anxiety disorders, Muris et al. (2003) found varying correlations between child and parent ratings on the RCADS, depending on the disorder – a distinction we were unable to make in this study due to sample restrictions. Our limited findings around significant moderation effects are perhaps surprising in the context of studies, such as Milan et al. (2017). In a moderation model including mothers' and daughters' depression ratings of themselves and each other, they found that "reports of the other person's symptoms were predicted from both how depressed the target person actually was based on self-report, and how depressed the reporter was" as well as that "bias effects were notably larger than accuracy effects, indicating that one's own depressive symptoms were a stronger predictor of how depressed the other person appeared, relative to how depressed that person may actually be." In other words, we replicated the first part of Milan et al.'s (2017) findings through the correlation between depression self- and parental report (or indeed anxiety or behavioural difficulties). However, our data did not yield a 'bias effect,' as there was no moderating effect of parental depression (or anxiety) on the ratings of their child's depression / anxiety / behavioural difficulties. The possibility therefore remains of a greater 'accuracy effect' in our sample, meaning parents were more apt at evaluating their children's symptoms regardless of their own level of symptoms, albeit estimating them at a significantly lower level.

Service user feedback. Early findings from this research were presented to a Young People's Mental Health Advisory Group (YPMHAG) in London in July 2017. The group raised several interesting feedback points.

The questionnaires in this study were largely presented to young clients and their families within an online framework circulated as a link via email (DAWBA; Goodman et al., 2000). As the questionnaires are aimed at exploring a wide range of potential mental health difficulties, they can take over an hour to complete per person, depending among other factors on the number and depth of written comments provided. The group was curious to find out about the acceptability of this to clients and whether the format would permit respondents to take breaks.

It was suggested that children could be under-reporting their own symptoms if they perceive their parents' symptoms to be worse. For this reason, the YPMHAG suggested that children could be interviewed on a 1:1 basis to gain a deeper understanding of their views. On a

related note, it wasn't considered surprising by the group that parents rated their child's symptoms as above cut-off, and it was felt that this is because parents are likely to worry.

The YPMHAG meeting also highlighted that the service may not routinely provide direct and detailed feedback to families about the questionnaire results. The group felt that this could be an additional incentive for respondents to complete them.

In terms of disseminating findings from this project, the group agreed that advertising results in clinic waiting areas could be helpful. However, the author should ensure that the service development aspect of this is clear as well as how service users can get involved again.

Service implications. The results of this service evaluation project have implications for the Mood & Bipolar Clinic and future service development.

For instance, child and parent measures were significantly correlated, indicating moderate overlap in what they were measuring. However, parents on average tended to rate their children's depression and/or anxiety symptoms lower than the young persons themselves. In addition, regression analyses suggest that self-report measures significantly predict children and young people's symptoms of depression, anxiety, and potentially also behavioural difficulties. Parental measures did not explain significant additional variance in these analyses, suggesting that for the present sample, more weight should be placed on the former. This research was unable to address whether this difference is due to a lack of insight of parents into their children's mental health difficulties or whether some children may have a tendency to rate their distress more highly compared to their parents. However, both options may be worth bearing in mind when a difference in child and parent ratings becomes apparent during an assessment.

The HADS was not found to moderate between child and parent ratings of depression, though it was found to do so for anxiety ratings when young people's age and/or gender were taken into account. The implications of this warrant further investigation. It is possible that the HADS depression subscale was not sensitive to eliciting a moderation in symptoms, though moderation findings have been discovered in previous research (cf. Milan et al., 2017). At a service level, parents may still be considered valid reporters of their child's depression symptoms (given the consistent correlation between these two) even if they are depressed themselves, though this finding has to be considered in the context of a small sample size. Family and systemic factors are clearly important in the development and maintenance of youth depression and need to continue to be considered (Sander &

McCarty, 2005). For instance, screening for parental mental health difficulties can help to identify undiagnosed challenges which may limit their coping resources.

As the YPMHAG pointed out, the questionnaires being completed as part of the DAWBA in this study put a significant onus on the respondents to complete all measures in time for their assessment. It may be worth considering established short-form versions of clinical measures (cf. Thapar et al., 2016) or additional service evaluation projects to determine the relative value of measures for differential diagnoses.

Limitations and future research. The results from this service evaluation project need to be considered in the context of various limiting factors. The project was conducted at a single South London service site. It is highly likely that the sample is skewed towards the more severe end of the spectrum given the national and specialist nature of the service within the NHS, though the service accepted waitlist referrals from another South London Tier 3 service for several months throughout the data collection period. This means the present results are difficult to generalize to other UK mental health contexts, including adult and older adult services, let alone internationally. Furthermore, analyses of child-parent agreement on an item-by-item basis, for example using intra-class correlation coefficients, was not possible as data were originally entered as total scores only, save for the SDQ. However, within the practical limitations of this project, it was not feasible to extract individual scores from raw data for over 200 participants. Lastly, the analyses for this project contained a substantial number of correlations and regressions, increasing the risk of Type-I errors. Consequently, a family-wise adjusted significance level ($\alpha = 0.003$) was applied to analyses under hypothesis 4, but not other analyses. There are more conservative methods of adjusting the significant level, e.g. the Bonferroni method. A risk remains of false positives among the findings for this project and results should therefore be interpreted with caution.

Future research should consider how child-parent agreement may develop over time and in the context of emerging or diminishing parental mental health difficulties as this would offer a richer understanding of the relationship between parent and young people's reports of mental health problems. Another approach could be to collect qualitative data on how parents and young people read and approach standardized questionnaire measures about their mental health, e.g., using a 'think aloud' approach. Subsequent studies should consider collecting larger samples or samples with a variety of anxiety diagnoses in order to examine how parental mental health difficulties may affect young people's and parents' responses on measures of a variety of anxiety symptoms. Lastly, due to the data collection beginning prior to the arrival of the main author, it was not possible to avoid different measures being used

for parental reports of their child's mental health challenges (e.g., MFQ) and of their own mental health (e.g., HADS). This was pointed out by the YPMHAG and later researchers should attempt to harmonize measures in order to reduce systematic biases due to variations in item wordings.

Conclusion. This service evaluation project aimed to investigate the relationship between young people's reported symptoms of depression or anxiety, parental reports of their children's symptoms as well as of their own symptoms using standardized measures. Correlations were discovered between child and parent reports of young people's depression, anxiety as well as more generic strengths and difficulties. In the present study, these two reports were not moderated by parental depression or anxiety, though this could be due to a variety of research limitations. Child ratings were more predictive of a new or additional depression or anxiety diagnosis than parent ratings. Service users have made a valuable contribution to clinician reflections about the impact of these findings on future clinic and assessment practices.

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